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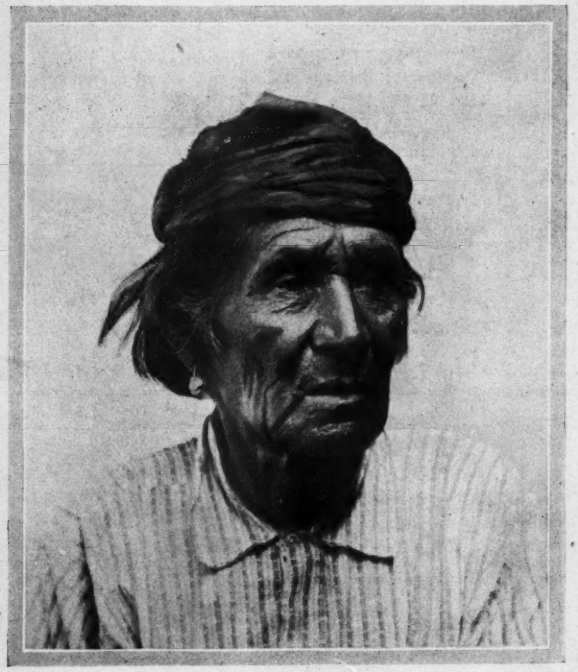

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Editorial Notes.

Great exhibitions like Wembley are transient things, although that giant conservatory the Crystal Palace still persists to recall Victorian glories. As a whole we are not sorry to see Wembley go, but there are certain exhibits which should be saved and made permanently available. The Science Exhibition is far too good to be casually dispersed into its elements, and it has shown that the public are genuinely interested in the latest developments of science, pure or applied. The secret lies in the demonstrations, for there is all the difference in the world between an exhibit of an instrument and a demonstration of the same apparatus in use. It is one of the oldest elements of salesmanship, this demonstration of the use of a thing in order to stimulate interest and a desire to acquire. In the case of science it is not salesmanship, but rather propaganda. No less important is the element of novelty; recent discoveries, new conquests—these are far more attractive than something, however important, which is now a commonplace of the text-books. It seems strange, and a reproach to us, if we cannot somehow find a home in one or other of the national museums, or in some connection with the world of science, for a small permanent exhibition on these lines. Failing permanence, there might at least be an annual show accessible to the public. Every May we see the courtyard of Burlington House choked with visitors to the Royal Academy. An annual science exhibition run under the auspices of the various learned societies might, if skilfully handled, prove to be almost as popular a feature of the London season. It could cover an enormous field from the Atom to Zoology, and it would help the general public to realize something of the vast scope of scientific work in every field. Is it a practicable suggestion? There would be difficulties and it would require a good deal of co-ordination, but the lesson of Wembley shows that there is nothing really impossible about it, and also that there is a very genuine public interest. We have heard a good deal about conveying a true presentation of modern scientific work and development to the public. One of the very best ways of doing so is to make science and scientific demonstrations accessible to them.

* * * * *

Two wireless exhibitions have been held recently. They were interesting in so far as they showed neater and better ways of making component parts and a refinement of general design, but they did not produce any outstanding novelties in the shape of new or more effective circuits. For the moment it can be said that there are a few reliable circuits which are used for most of the commercial sets, and design is relatively stabilized. The improvements of the year are all matters of detail. No great forward step has been achieved. Broadcasting has settled down from the boom period to a steady-going household necessity no more remarkable than electric light, but it will be a matter of some considerable time before Europe is so linked up that the average possessor of a moderate rather than an expensive set will be able to rely on picking up any given foreign long-distance station. As the power of continental stations is increased this will become easier, but super-power stations also introduce difficulties of their own. The quality of selectivity in sets will become increasingly important. Some experts hold that new inventions will be made which will supersede all our present apparatus. Others, no less authoritative, say that this, though possible,

is not particularly probable, and that it is better to compare wireless apparatus of to-day with the motor-car of twenty years ago. The essentials of our modern cars were all embodied in these. It is advance in design and in material which makes the record of twenty years of progress. As for the improvement in the quality of the matter broadcast, this, I am afraid, will have to be thought of in terms of generations, or at least decades, of thought, rather than mere years.

* * * * *

The death of Professor Lefroy robs the world of science of one of its most useful workers. Entomology is capable of wider practical applications than mere butterfly collecting, and the late Professor Lefroy's contributions to practical knowledge were of national, indeed, worldwide importance. It is to him that we owe our knowledge of the life cycle and habits of the death-watch beetle. His most enduring monument will be the old churches and old wood-raftered buildings which his knowledge has saved for us and our descendants. His name will endure on the roll of permanent achievement when the bought titles of gentility of successful business men are forgotten. He died at his work, in the full tide of his work, and too early. The spirit which permeated his research work, that sense of the necessary practical scientific control and domination of the insects whose activities are noxious to human welfare, he has left as a legacy to those who worked with and under him, and even though a leader may fall the work will still continue.

* * * * *

The present trend of research on cancer is admittedly very hopeful, but for the moment results are confined purely to inoculated cancer rather than to naturally occurring cancer, and the extension of the curative measures from experiments on animals to the actual treatment of human sufferers is not yet a possibility. Doctor Lumsden, who is working at the Lister Institute of Preventive Medicine, has succeeded in producing an anti-serum from horses which is successful in destroying cancers in rats. The action of the anti-serum not only exercises a direct effect on the tumour, but also induces a vaccine which is formed apparently from the breakdown of the tumour itself. This vaccine not only effects a complete cure of the tumour, but immunizes the animal against further cancers, so that new inoculations of cancer fail to take. There are many steps to be taken before the treatment will have reached a stage where it will be safe to take the bold step of applying it to cancer patients, but the announcement will be made as soon as the results of experiment justify it. At the moment all that may be said is that the course of the present researches looks extremely promising. The obstacle may conceivably be found in the difficulty of finding a " specific agent " in some animal which will yield a serum effective in the human animal. Doctor Gye, it will be remembered, found that the cancer organism needed a " specific agent " which did not appear to be the same in different kinds of animals. Doctor Lumsden has now moved to the point where horse serum is able to cure rat virus. Few people, except those who are connected with medical research, realize how much trouble has been caused by that reactionary organization the Anti-Vivisection Society. In research work experiment and control may involve the inoculation of a hundred or more mice, rats, or guinea pigs daily. The " operation " consists merely of a prick with a needle, but, nevertheless, legally it counts as an operation, and a proper form has to be filled up about it and rendered to the proper authority. This requires time and labour, and where big quantities of material are used it becomes a serious burden. Sane legislation was perhaps desirable to prevent the remote possibility of abuses, but it should always be borne in mind that legislation of this character may cause bitter suffering to humanity and to other animals. The research which leads us to hope for a solution of the cancer scourge, the researches which may relieve the dog world of distemper, and eliminate foot-and-mouth disease among cattle, all involve experiments on animals. This should be recognized and made clear to the uninformed people who are the supporters of reactionary organizations based on sentiment rather than sense. There are serious dangers associated with these crank groups, for if they had their way they would make research which is destined to save uncounted thousands of human lives entirely impossible.

* * * * *

Two French scientists have claimed that fragments of a meteorite contained the spores of germs and forms of life which they were able to grow in cultures in the laboratory. Their claim is received with some scepticism, for the conditions of extreme cold in space and the violent heating effect on a meteorite entering the earth's atmosphere, not to mention ultra-violet rays and electrical effects, would seem to render life impossible. Assuming that they are right, and that no accidental mundane contamination has taken place, it may provide the writer of fiction with a scientific trend with a new plot basis—the arrival of a new and noxious microbe as a present from one of the planets.

Indian Trails in the South-Western States.

By L. H. Dudley Buxton, M.A., F.S.A.

The American Indians are a vanishing race. Their tribal traditions and customs are extremely important, for they throw light on the original racial stocks of the tribes. The Hopis have been largely investigated, but much yet remains to be extracted from the Navajos.

Six o'clock one morning in the late autumn I found myself standing rather lost on the station platform of a little town in Arizona. I had come directly across the States from Washington, D.C., and for the moment I felt very lost or, as my Indian friends would say, I did not know the trails. I came with letters from the Indian Department in Washington to see something of the life of the Indians in the great American desert. The sun was just rising with the promise of a hot day, but there was a chill in the clear desert air, and I wrapped my British Warm, converted to civilian usage, round me and wondered how I was to get out into the Indian country a hundred miles or so away.

INSIDE A MEDICINE MAN'S LODGE.
The ball hung to the upright is a "medicine bundle." Notice the "key pattern" on the rug he is sitting on.

The Agency.

The British Warm proved my salvation; I was having breakfast in the only restaurant the town boasted when a man with spurs and chaps and the general accoutrements of the Wild West, which I thought only survived on the cinema, lounged over to me and said, "You're a Britisher?" I replied that I was. He showed me a discharged soldier's silver badge to prove that he was a Britisher too, and on the presumption that nobody wanted to stay in Holbrook, my little desert town, asked me where I wanted to go to. I told him my business and, fortune favouring the wanderer, he told me that the mail was going out to an Indian Agency, to which I had letters of introduction, that very morning. I was introduced to the mail driver, who carried the mails to the Indian trading posts and agencies, and later in the day we started off.

For a mile or two there was a road, and after that a track which turned and twisted through the sparse desert vegetation, and in the higher ground passed every now and then between stunted cedars of a kind which produce a sort of nut in their cones, much esteemed by the Indians, and closely paralleled in their effects with green apples here. Every now and then we came to an Indian trading post. Two especially struck me: the first, "Indian Wells," was the first place where I ever saw an American Indian in his own home; and the second, "Jeddito Springs," otherwise called by a jawbreaking Indian name meaning "the place where wild pumpkins grow," was so delightful a hamlet in the wilderness that I returned there later, when I began to study the Navajos in earnest.

Our journey ended ninety miles away from Holbrook at the agency of Keams' Canyon. Old Keams was a Scotch trader who came out there in pioneering days. He built a store in the canyon which bears his name, married an Indian wife—I saw one of his daughters later—and I believe eventually came home. Close to his store are the buildings which make up the headquarters of the reservation, a few houses, an office, a store, and a hospital.

Private Coal Seam.

I was given a house all to myself, but I had my meals with the staff of the hospital. My house had one great convenience: there was a shallow seam of coal in the back yard. When I was cold I turned miner and dug out a few lumps for the stove. It was from here that I visited the villages of the Hopi Indians, a strange race of cliff dwellers, celebrated even in the days of the Spanish conquistadores for their remarkable architecture and to-day for their wonderful religious dances.

From the beginning, however, I must confess to a greater interest in their old foes, the Navajos. To-day fighting is forbidden, but in the old days the Hopis retired to their inaccessible cliffs, and the Navajos, often

NAVAJO BOY STARTING OUT TO TEND SHEEP ON HIS BURRO.
The camp can just be seen on the left of the picture.

with considerable success, spent their spare time in raiding the Hopis, whom they called in derision *Moquis*, "dead men," a name which still sometimes is given to them. Living among the Hopis I saw the Navajos always as strangers, enemies to be cheated if possible, and the methods used were often entertaining.

Photographic Difficulties.

The Hopis are agriculturists and grow Indian corn, pumpkins, melons and peaches. The Navajos live entirely on their flocks and herds. Sometimes the Navajos come into the Hopi villages to trade. Among the latter all the property is in the hands of the women, who bring corn and vegetables to exchange for the Navajo meat. Usually these old ladies are more than a match for mere man in the shape of a Navajo wishing to trade meat. I have often watched them bringing along melons and carefully hiding them in an odd corner, while they went to inspect the meat. If it pleased them they bargained and did not produce their goods till the bargain had been struck. I photographed some Hopi women inspecting a Navajo's meat. It was taken in Hotavilla, supposed to be one of the most uncivilized villages in the United States. They all had their backs to the camera; I sat down and photographed with the camera held between my legs, when no one was looking, because the last man who tried to take their pictures was roughly handled. On this occasion the old Navajo was badly cheated by these careful old ladies. Next time he came he got his own back: he brought his own wife to deal with the situation.

After some time spent in the Hopi villages I went back to Jeddito Springs. Here there was only the store, where Roberts the trader and his wife lived, and Indian camps round about, for water was to be had. Roberts knew the Indian languages and told me many tales about their life and origin, at odd times when there was no Indian in the store.

The name Navajo, he told me, first appears in the seventeenth century, and is derived from an Indian village near Santa Clara in New Mexico. The Spaniards first applied it to the people we call by that name under the full title of Apache de Navajo. The people call themselves "Dinneh," which means simply "men." There are great differences between them, and those who lived round Roberts' store differ considerably from those I met later at Leupp.

Trade in the store was usually brisk, and was carried on to a great extent by barter, although values were calculated in dollars and cents. Turquoises form, as it were, the basis of native prices. The Indians value these stones very greatly, and wear them mounted in silver as rings, heavy bracelets and belts. They also possess unmounted stones. The men used to ride in, and brought with them either turquoises or wool. The latter was usually mixed either intentionally or unintentionally with sand and skins, so it took a long time to calculate its value. When they have a lot to sell they learn the current prices, and then go outside and calculate the value of their goods with bits of stick. I do not quite know how they do it; they do not seem to be able to manage multiplication or division, but work everything out by simple addition and subtraction, often quite long sums.

This is a normal sort of transaction. An old Indian came in and traded skins. Then he set about replenishing his wardrobe. First he bought a blanket, next a pair of overall trousers (locally "pants"), next a new overcoat, which he put on immediately, for winter was coming on and it was getting cold. Then, after much deliberation and little strolls into the sun outside to think matters over, he bought a shirt.

Choosing Hats.

Finally he found a "beaver hat" which suited him. This was a low-crowned close-fitting hat made, I think, of sheepskin dyed black. He was most particular over this hat. When he had finished bargaining for it he took off the handkerchief which was bound round his head and put it on, and tied the hat box to his saddle-bow with the handkerchief. Then he scientifically packed everything on to the saddle and, having lounged round the store for an hour and a half, rode off into the desert.

Meanwhile we had several other excitements. A woman came in very much aggrieved. It appeared

that there was a great " singing " or magical ceremony about sixty miles away. Some chief or other was ill, and all the medicine men had gone there to dance, so as to cure the sufferer. The woman's grievance was that the local medicine man was away; her small boy was suffering from a surfeit of the delectable cedar nuts, and there was no one to attend to him. I prescribed a little Epsom salts, known to be magical —there is a devil in them which runs down the throat with a burning feeling if you add water and recite the proper formula—and she departed.

Mothers-in-Law.

Suddenly someone threw a blanket over the head of an inoffensive old lady who was standing in the store. I asked Roberts Why this unprovoked assault? It appeared that the young man who had come into the store was her son-in-law. If he had looked at his mother-in-law he would immediately have become blind. This saves a lot of trouble, and the course of true love usually runs smoothly. When a man wants to marry a girl he arranges with the father of the girl to pay the clan so many sheep, goats and horses. This bride-price is very much a family affair, and the young people have a good deal of choice in these matters. But they must always marry a person of a different clan: the "Big Water Bears," for instance, may marry into the " Deer Spring " clan, and " Bitter Water " people into the " Many Goats," but no " Deer Spring " man can ever aspire to the hand of a " Deer Spring " maiden.

Sometimes it will happen that a rich old man will set his fancy on a young squaw of a poor clan. In this case her family will often insist on a *mariage de convenance,* but it is not common. On the day of the wedding the young man and his father go to the bride's home, bringing the bride-price. If this is

THE OLD MEDICINE MAN WHO TOLD ME THE NAVAJO FOLK-TALES. The man on the right is Mark, my interpreter.

AN INDIAN POLICEMAN EMPLOYED BY THE GOVERNMENT. All his gear is non-Indian except the saddle blanket which is characteristic of the Navajo patterns.

satisfactory (which, of course, it always is—they have been bargaining for a long time beforehand), the wedding ceremony takes place.

The essential part of this ceremony is the eating of special cakes from a particular and very beautiful basket, flat and very finely woven. As the Navajos do not make baskets, I was surprised at this, but discovered that these wedding baskets are made by Piute women, of quite a different Indian tribe. The Navajos say that in the old time they were made by Piute women who had been incorporated into the tribe.

Remote Villages.

I did not see anything of the Navajo villages till I had left Jeddito Springs and had taken a long journey, partly by train but mostly by car, to the Western Navajo agency which lies over a hundred miles away at Leupp on the Little Colorado River. Here the Agent very kindly put a car and an interpreter at my disposal, and I wandered many miles over the country in search of Navajo villages. They are often difficult to find, as the people wander far. The Indian territory includes some of the remotest parts of the United States, and covers over 22,000 square miles—nearly half the size of England. The most distant place to which the mail is carried is Tyende, 165 miles from the nearest railway station, and the north-western part of the reserve beyond the most distant stores is very inaccessible.

Our journeys then to look for Navajo villages often took us—Mark, my interpreter and chaffeur, a full-blood Navajo, and myself—far afield. I made many such journeys, and the one I am going to describe is fairly typical. We left the agency one day at dawn and took the old Indian trail to the north-west, the trail the Navajo war parties used to follow in their raids on the Hopis. The trail led out beyond the Canyon Diabolo, the true Devil's gulch through which the Little Colorado runs, over the plain covered with little but sage brush and sand. Then we climbed on to the top of an old canyon rim and looked across the bed of an old lake towards a magnificent cliff, the Red Mesa. The cliffs are of red sandstone, and the sun lighted them up, leaving the plain in shadow, and the cliffs looked for all the world like "a rose-red city half as old as time." I could have sworn that the shadow of one of the broken cliffs was a ruined postern gate. Here in the flats between the canyon rim and the cliffs we found Navajo villages.

A NAVAJO GIRL.

Houses.

Each village consists of a few houses. They are made of timbers set in two courses. The lower timbers are arranged upright, set closely side by side, varying in height but usually about five feet high, the interior being lined with horizontal timbers. On the top of these timbers are set horizontally each succeeding layer, forming a smaller circle than the last. These top timbers were plastered with mud. There is a smoke-hole in the centre which forms also a window. The inside is about twenty feet across and ten feet high at the centre, where there is usually a fire smouldering. The floor is covered with a number of sheepskins, which make quite a comfortable couch. For other furniture there is often a loom or two. They weave beautiful blankets and as only small blankets can be made inside, they move the looms out of doors in the fine weather. You will find a stone quern for grinding the corn somewhere around, and a baby's cradle, simply a board with a little hard pillow for the head, a small hinged piece of wood at the foot, which is tied to the soles of the baby's feet. That is all.

If the owner of the house is a medicine man his "medicine bundle" may be hung up. You can see it in the photograph. This mysterious bag is made of buckskin, and no one but its owner may look into it. It contains, I believe, turquoises, eagles' feathers, dried herbs, and other mysterious ingredients. Sometimes it forms a secret cache. An old woman took some famous turquoises to a "singing," and when she was there she lost them. An old medicine man was suspected of stealing them for they disappeared, but nobody knew for certain until he died. Then his family solemnly opened his medicine bag and the missing stones were found inside. They divided them up and some got into trade. One of the family to whom they had belonged recognized one of them years afterwards and they were bought back.

I often used to sit in the Indian houses, and they were very hospitable. Their occupations at home were simple. The women used to weave, or nurse their babies. The men for the most part seemed to do little. Sometimes they made moccasins. They cut out the leather and sewed it without a needle, moistening the thread and passing it through holes made with an old knife sharpened to a point, and tying it neatly when the length of thread, usually about ten inches, was finished. They decorate their moccasins with 25-cent pieces. A silver ring is soldered to the centre of the coin which is then tied with thread to the moccasin. When an Indian is hard up he cuts a coin from the moccasin, and I possess one that still has the ring soldered to it. It came to me as change in an Indian store.

Pasturage.

Much of the work of looking after the sheep falls on the shoulders of the children. If you visit an encampment about dawn you will find little stirring except a woman or two making a fire, and the boys and girls getting ready their donkeys to ride with the sheep to the pasture. During the night the sheep

are kept in a corral made of wooden uprights fastened close together to protect the flocks from prairie wolves and bears.

Beside the houses and the corral there is nearly always a sweat lodge in every encampment. This is a little dugout timbered like the houses and about six feet across and under three feet high inside. Half is carpeted with grass, and in the other half they heat stones over a wood fire. When the stones are hot the Indian who is going to have a sweat bath goes inside, blankets are placed over the sweat house and the occupant puts the stones into water, and the house is immediately filled with steam.

In addition to these permanent structures the Indians built " summer lodges " of green cedar boughs in the pastures. They are often on the move, and so they usually possess more than one permanent house in different places. They live entirely by stock-raising, and it is surprising, considering their nomadic habits, that they think it worth while to build these solid houses, especially in a country where timber of any sort is very rare.

Beliefs and Folklore.

When a man dies the house in which he died is abandoned, for the ghost would be jealous, they told me, of any successors. A man is always buried in his silver and turquoise personal ornaments and, if he be rich, his horse is fully saddled and killed at his grave, but not buried. I asked Mark, the interpreter, what happened to the souls of the dead. His English, normally good, failed him. He said he guessed it was not heaven ; it might be what the Whites called hell, but there was no fire there.

This seemed an unsatisfactory story, and later I was fortunate in finding out more. I had the misfortune to hurt my leg and had to lie on a couch. The most reputable medicine man came to see me every day, and although I did not allow him to treat me as he wanted to—my leg was too painful—he told me many stories of his race.

The stories, like all savage folk tales, were very fascinating, but are too long to be told here in full. He told me that the Navajos came in the old days from a deep hole in the ground up in the north in Colorado. When they had gone four days' journey to the south they missed one of their company, a woman, so they went back and looked into the hole. There they saw her combing her hair. She said she was dead, and everyone who died would go back there to the place where they originally came from. This explained Mark's story.

The old man was very interested to hear about my journeyings, but refused to believe that if I went always towards the rising sun, as I said I was doing, I would come back home again. Finally one morning he asked me, " Do you know the trail ? " I said I did. " Then," he said, " you will come home safe." And to make assurance doubly sure he gave me a turquoise to protect me on my journey.

ADVANTAGES AND DISADVANTAGES OF ALCOHOL AS A MOTOR FUEL.

DURING the past three years two American chemists, Messrs. Freeland and Harry, have investigated very closely the possibilities of substituting alcohol, manufactured from molasses, for petrol in engines designed for petrol. Among the advantages they find (1) it generates less heat by combustion and, consequently, requires less cooling water ; (2) the cylinder temperatures are lower, thereby preventing cylinder lubrication difficulties ; (3) the rate of flame propagation is less and the pressure more nearly uniform through the entire stroke of the piston, resulting in smoother operation, less vibration and " knocking " ; (4) the engine develops 10-20 per cent more power than when petrol is used, and at any one compression gives a greater thermal efficiency ; (5) it can be used at much higher compressions than petrol without danger of pre-ignition. The best compression pressure for petrol is 70 lb. per sq. in. compared with 180 for alcohol.

It does, however, possess certain serious disadvantages, chief of which are (1) having low volatility, it is difficult to obtain an explosive mixture of air and alcohol in cold weather ; hence difficulty in starting when " cold " ; (2) the explosive mixture is very different, being 9.5 to 11.5 parts of air to one of alcohol, by weight, compared with 15 to 23 of air to one of petrol, when used at the same compression. This necessitates an alteration in the jet adjustment ; (3) the explosive mixture is formed within narrower limits, consequently the engine has a much lower flexibility.

FREEZING THE SARDINE.

M. GRUVEL, the Professor of the Paris Museum of Natural History, is preparing a refrigerating plant for the investigation of colonial produce. Among other problems M. Gruvel intends to examine the possibilities of freezing sardines. Whether this means that the familiar sardine tin will disappear from the beaches of our seaside resorts remains to be seen.

Teredo, the Shipworm.

By C. M. Yonge, Ph.D., B.Sc.

The Teredo has so far resisted all the attempts of scientists to defeat it. It represents one of the most efficient adaptations to its mode of life, and it is only recently that we have learnt exactly how it functions and details of its life cycle.

SINCE the days of the ancient Greeks and Romans the shipworm, the "calamitas navium" of Linnaeus, has been known and feared on account of the great destruction it causes to all timber in seawater, and particularly to wooden ships and harbour works. Greek tiriremes, Venetian galleys and Drake's famous ship "The Golden Hind" all were rotted away by the boring of these creatures, while in 1730, by eating into the dykes of Holland, they threatened the very existence of that country. Even to-day, although steel ships have nothing to fear from them, they cause extensive damage to wooden piers and wharves. Destruction estimated at ten million dollars was done in San Francisco Bay as the result of the great spread of Teredo in that region between 1914 and 1920.

Mollusc, not Worm.

In spite of its common name, Teredo is no worm, but is a bivalve mollusc, though this was not recognized until 1733 as a result of the work of a Dutch investigator appointed to inquire into the cause of the damage which had been done to the dykes. But, though it agrees in all essential structures with such typical bivalves as the mussel or the oyster, it is so specialized on account of its peculiar method of life that at first sight it seems to bear no resemblance to them, while its elongate form immediately suggests that of a worm.

The shell valves (as will be seen in Fig. 1), instead of covering the entire animal as in a typical bivalve, are very small and confined to the extreme front end of the animal. Between, and slightly on the under side of them, lies a round sucker known as the foot, while immediately above that is situated the mouth. At the other end of the elongated unprotected body there are a pair of short tubes, the siphons, and at their base two calcareous paddle-like plates known as the pallets. During life the siphons project into the sea through the opening of the burrow in which the animal lies and a constant stream of water passes through one of them into an open passage, the inhalent gill-chamber, which extends almost the entire length of the animal. This is separated from a second, or exhalent, gill-chamber by a finely perforated partition, the gill, which is covered with delicate constantly-moving hairs or cilia which are responsible for the flow of water through the gill chambers. The water passes through the tiny interstices in the gill, leaving behind it any suspended particles which are carried to the mouth, and enters the second chamber in which it flows backward and is expelled through the second, exhalent, siphon. If the siphons are touched, however lightly, they are immediately drawn back behind the pallets which are pushed forward so as to close the opening of the burrow. This opening is very small—not much bigger than a pin-head—but within the burrow widens out until it may be half an inch or more across. It is lined everywhere except at the inner end by a smooth calcareous substance which is laid on by the animal.

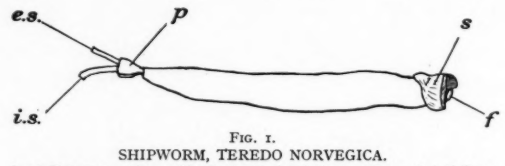


FIG. 1.
SHIPWORM, TEREDO NORVEGICA.
(*e.s.*) Exhalent siphon; (*f.*) Foot; (*i.s.*) Inhalent siphon; (*p.*) Pallets; (*s.*) Shell valve.

The inner end of the burrow only remains uncoated so long as the animal continues growing and actively boring; as soon as it ceases burrowing, either on account of age or lack of further wood to bore into, this end also is coated over and a limey tube is formed which entirely surrounds the animal except for the opening at the hind end.

How it Bores.

For a long time naturalists were very divided in their opinions as to how Teredo bored into wood—saying that it did so by the suction of the foot; by the rhythmical passage of the water in and out of the body; by the help of some substance which dissolved away the wood; or by the mechanical boring of the shell valves. This last explanation has found most support, and quite recently an American scientist, Dr. R. C. Miller, has published a paper which seems to settle the matter once and for all. In order to understand the beautiful mechanism employed it is necessary first to describe the structure of the shell (see Fig. 2). The valves are very irregular in outline, but they can

be divided into three portions, a posterior lobe consisting of a broad wing often known as the auricle, a median lobe which forms the mass of the shell and is curved so as to form a semicircle, and an anterior lobe which only extends for less than half the width of the median lobe and is then cut away at right angles. The outer surfaces of these last two regions are covered with a series of sharply-pointed ridges, those on the median lobe passing diagonally across the anterior third of its surface, while those on the anterior lobe run parallel to the sharply cut lower margin. These latter ridges are continually being added to during the life of the animal. On the inside of the median lobes are two knobs, one above and one below, which are known as the dorsal and ventral articulations respectively, while extending down from the former of these is a long process, the apophysis, which gives attachment to the muscles of the foot. Now imagine the two valves placed one against the other. They will be attached by the two pairs of knobs and will be able to rock backward and forward upon these two points so that the edges of the valves will describe an arc of between twenty and thirty degrees. It is by means of this rocking movement, as we shall see, that the animal is able to bore. Two muscles are attached to the shell and are responsible for the working of the boring apparatus—a very large posterior adductor muscle attached to the inner sides of the auricles and a much smaller anterior adductor attached to the inner surfaces of the anterior lobes.

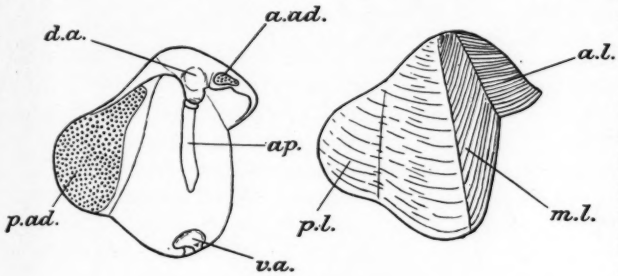


FIG. 2.
SHELL OF TEREDO.
Interior on left. Exterior on right.
(*a.ad.*) Anterior adductor muscle; (*a.l.*) Anterior lobe; (*ap.*) Apophysis; (*d.a.*) Dorsal articulation; (*m.l.*) Median lobe; (*p.ad.*) Posterior adductor; (*p.l.*) Posterior lobe; (*v.a.*) Ventral articulation.

Peculiar Action.

The wood at the lower side of the head of the burrow is gripped by the foot which acts as a sucker, while at the same time a flap of skin which overlaps the shell valves grips it above, as shown in Fig. 3. The shell is thus pressed firmly against the wood and is ready to begin boring. To do this the powerful posterior muscle is contracted, drawing the anterior lobes apart so that the sharp ridges with which they are covered scrape off the surface of the wood at the end of the burrow, while at the same time the ridges on the median lobes widen the opening behind. The small anterior muscle now comes into play and by contracting draws the anterior lobes together again—a much easier operation since the surface of the wood offers no resistance to movement in this direction. The foot then loosens its hold and moves a very slight distance laterally, when the same operation is repeated. This goes on over and over again until the shell and front half of the body have been twisted completely round from their original position, when the movement is reversed. As a result of this continual turning of the shell the inside of the burrow becomes perfectly smooth and circular. The whole mechanism of boring is a model of efficiency, and yet it is an adaptation of the purely protective shell possessed by the typical bivalve.

Wood as Food.

The fragments of wood scraped off are swallowed and make their way through the body before being ejected by way of the exhalent siphon. It has long been a matter of dispute whether Teredo can actually digest the wood or whether it passes through the body unchanged, but recent investigations seem to point to the animal being able to feed to some extent upon the wood into which it bores. There is a large extension of the stomach which is always filled with wood shavings and is obviously well adapted for the storage of a slowly-digested diet such as wood, and we have some evidence that ferments are produced which can convert wood into sugars which can be absorbed.

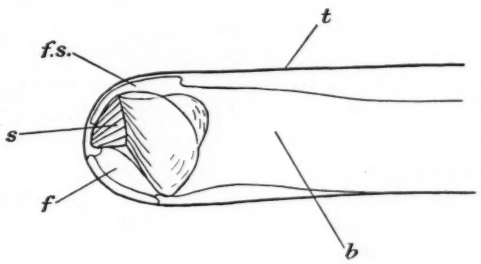


FIG. 3.
BORING POSITION OF TEREDO IN END OF TUBE
(*From Miller*).
(*b.*) Body; (*f.*) Foot; (*f.s.*) Fold of skin gripping burrow above; (*s.*) Shell valve, left; (*t.*) Lining of tube.

It is easy to see that once incased in his burrow no shipworm can ever leave it, and if animals are dissected out of the wood they are quite unable to form new

burrows. How then does infection spread with such alarming rapidity? During the summer months the sexual products, eggs and sperms, are discharged in immense numbers through the exhalent siphon into the sea where the eggs are fertilized and the young organisms begin to develop. In a few species, such as the common *Teredo navalis*, the eggs remain in the gill chamber and early development takes place there. Development proceeds on exactly the same lines as in any other bivalve, and after a few days a little "larva" (Fig. 4) is formed possessing two shell valves which entirely enclose the body. These larvae swim freely by means of a circle of cilia which they can project between the valves. It is not known for how long they remain in this state, but they can probably do so for several weeks, during which time they may be carried by ocean currents or other agencies for great distances. This is the only period during its life when the shipworm possesses the power of locomotion, and it is then that it is able to spread by infecting fresh timber. Wood appears to exercise some kind of chemical attraction for the larvae, which will remain on its surface once they happen to drift there, whereas they will not remain on stone or any other hard surface. An extract of wood made with ether or alcohol has the same attraction for them.

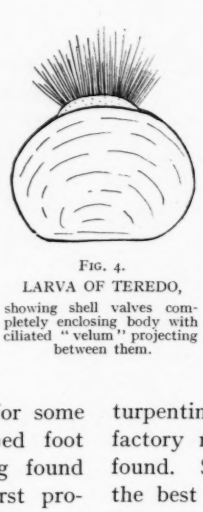


FIG. 4.
LARVA OF TEREDO,
showing shell valves completely enclosing body with ciliated "velum" projecting between them.

Adaptation.

After they settle on the wood the larvae begin to change. They lose the ring of cilia but are able to crawl about for some time by the aid of a long tongue-shaped foot which they develop at this stage. Having found a good place, they finally begin to bore, first protecting themselves, it is said, with a covering of wood and other particles. Both shell and foot are quickly converted into those of an adult Teredo, while the body grows more and more elongated as the burrow becomes longer. Usually they enter the wood at right angles to the grain, but they soon turn in the direction which it runs. However full a piece of timber may be with Teredo, the burrows never run into one another, rather than do that they will turn and twist and interlace with one another in the most complicated manner, as an X-ray photograph of a heavily infected piece of timber shows very clearly. A stout piece of timber may be so completely eaten away that it can be crushed between finger and thumb.

From a scientific point of view the most interesting feature about the shipworm is the remarkably efficient way it is adapted to its strange mode of life. Originally, as the structure of the larva tells us, like any other bivalve it has in the course of ages evolved the elongate body of a boring animal and a shell which has lost its original protective function, developed a second, ventral, articulation, a characteristic shape and a series of sharp ridges, and so become a boring tool. This is worked by means of a pair of muscles, one of which is some thirty times the size of the other—although in the bivalves generally they are about the same size and serve to close the shell. It possesses a foot which acts as a sucker, a pair of pallets (not developed in any other molluscs) for the protection of the opening of the burrow, a modified digestive system for dealing with the wood taken in, and probably especial digestive ferments. There is no better example in the whole of the animal kingdom of that adaptation to circumstances which is so marked a character of life.

Six-foot Worms.

There are many species of shipworms, some of which may attain a length of from five to six feet with burrows as much as an inch wide, but the English species are never more than eighteen inches long. The rate of growth is very rapid, so that immense damage can be caused in a very short time. All kinds of timber are attacked, though some, such as greenheart, jarrah, and turpentine, resist longer than others. No satisfactory method of protecting wood has yet been found. Sheathing with metal, preferably copper, is the best way, but is too expensive for general use. Impregnating with creosote or other poisons is often successful as long as the surface layer remains intact, but as soon as this becomes damaged Teredo gets in, for an exposed area no bigger than a pin-point will supply surface enough for the attachment of a larva which may develop into a shipworm five feet long. It is the problem of finding some substance which, when impregnated into wood, will make it for ever poisonous to Teredo which is to-day occupying the attention of scientific workers both in this country and in the United States. Until some such substance has been found the shipworm will continue to be a menace, as it has been since the dawn of history, to all wooden structures exposed to the action of seawater.

Solving Greenland's Historic Mystery.

The Exhumation of an Ancient Norse Churchyard in Southern Greenland.

By Harold J. Shepstone, F.R.G.S.

The mysterious fate of the early white settlers in Greenland has always remained a puzzle to historians and scholars. As a result of some decidedly interesting excavations recently carried out at Herjolfsnes, in Southern Greenland, where a number of coffins and shrouds, in addition to an array of miscellaneous articles, were exhumed, brought to Copenhagen and there subjected to a scientific investigation, we get some idea of the possible fate which overwhelmed the descendants of the first colonizers of Greenland.

THE excavations carried out by Dr. Poul Norlund, of the National Museum, Copenhagen, at Herjolfsnes, the old Norse settlement of Osterbygd, in the present district of Julianehaab, in Southern Greenland, throws much interesting light upon the mysterious fate of the early Norse settlers in this land of the far north. In the ancient churchyard at Herjolfsnes, some two hundred valuable relics, having reference to some 120 different burials, were found. Many coffins were unearthed, as well as skeletons of the old Vikings in their shrouds, well-preserved articles of clothing, implements, tools, ornaments, and miscellaneous articles, including an imposing array of Christian crosses. In addition to these discoveries a careful examination was made of the ancient church as well as the dwelling-house, stables, and outhouses of the farm that stood here. In the height of its prosperity Herjolfsnes boasted of its harbour, and was the principal trading port of the country, while its church was the third in point of size of the sacred edifices erected by the Norsemen in Greenland.

THE FINDING OF THE FIRST COFFINS.
The coffins were in a bad state of preservation, and nothing was found in them but a single cross.

The Expedition.

It was in the summer of 1921 that Dr. Norlund and his party landed in Greenland, and after examining the ruins of various Norse settlements proceeded to Herjolfsnes. At first inclement weather and the ice hindered their movements, and it was not until the beginning of July that excavation work was begun, which continued without a break until 27th August, when attention had to be given to the packing of the many relics that had been found. On account of their age and the delicate nature of many of the finds, particularly the garments, it was most essential that they should be handled very carefully, and when they finally arrived at the Museum in Copenhagen they had to be examined and classified. This work occupied considerable time, but the result has now been embodied in a bulky volume of the publication "Meddelelser om Grönland" (Communications on Greenland), which future scholars will regard as an important archaeological contribution concerning the fate of those hardy and daring Norsemen who settled in Greenland in the early centuries.

Herjolfsnes, the scene of the excavations, is a barren, bleak spot, at the foot of Ikigait, an imposing headland, right on the seashore and destitute of any habitation. The only life the excavators found when they rowed

THREE GENERATIONS.
Reading from left to right: A man's dress, short-sleeved, large-waisted and of heavy material; a child's dress; dress of a girl, presumably about ten years of age.

ashore were the wild ravens who circled above them declaring loudly their displeasure at being disturbed. Herjolfsnes was founded by an Icelander, Herjolf Baardson, who followed Eric the Red to Greenland in about the year 986. It was Eric the Red who discovered and first colonized Greenland, and for a period of 250 years Greenland was an independent state, when it came under the sway of the then ruling King of Norway. By the twelfth century the population of the Greenland colonies could not have numbered less than three thousand. They boasted of their cathedral, monasteries, fourteen churches, and

Mysterious End.

240 large farms. A brisk trade was maintained with Europe till towards the end of the thirteenth century when it began to decline, and by the fifteenth century it had ceased altogether. It is common knowledge how when Hans Egede, the Danish Lutheran clergyman, went there in 1721, he only found savage nomadic Eskimos, and from that time to this historians have argued over the fate of the early white settlers.

The very location of Herjolfsnes was lost and its site was not discovered till 1830, when a missionary visiting the region found an inscribed tombstone used as a capstone over a door of an Eskimo hut. A few years later, as the result of the encroachment of the sea at this spot, a coffin was uncovered, and a Danish official, Ove Kielsen, as a result of a trial digging lasting two days, definitely located the ancient cemetery. Several coffins were found in addition to a skull with the hair preserved, the light colour of which proved definitely that the buried bodies could not be those of Eskimos, but must be remains of the medieval Norse population. Interest in the ancient churchyard having been aroused, the Royal Society of Antiquarians deputed Kielsen to make more extensive excavations and, though he dug over the greater part of the cemetery site, the results were disappointing, nothing of any great value having been found.

Churchyard Site.

Yet every time the sea carried away part of the shore, fresh burial remains came to light which led the Danish Commission, a body responsible for the scientific exploration of Greenland, to open up negotiations with the National Museum in Copenhagen for a technical excavation of the churchyard site. It is fortunate the work was no longer delayed, as the sea was slowly but surely swallowing up the ancient ruins. There is no doubt that the coastline has been considerably altered at this spot during the last few centuries. Herjolfsnes's ancient harbour has completely gone, and so has half of the churchyard, including a large portion of the southern wall.

It was not easy at first to locate the exact site, for the ruins were found to be almost completely overgrown with grass, only a few stones peeping out here and there. The first task of the excavators was a series of draining operations. Some small stagnant fresh-water lakes in the vicinity were drained dry to prevent too many raids by the dreaded mosquitoes. Then the many little rivers streaming down from the mountains across the field of operations were diverted. This precautionary work proved invaluable in keeping out the water as the digging proceeded and the coffins and shrouds were uncovered. The digging was carried out by Eskimos who proved themselves good workmen.

On July 8th a wooden cross was unearthed,

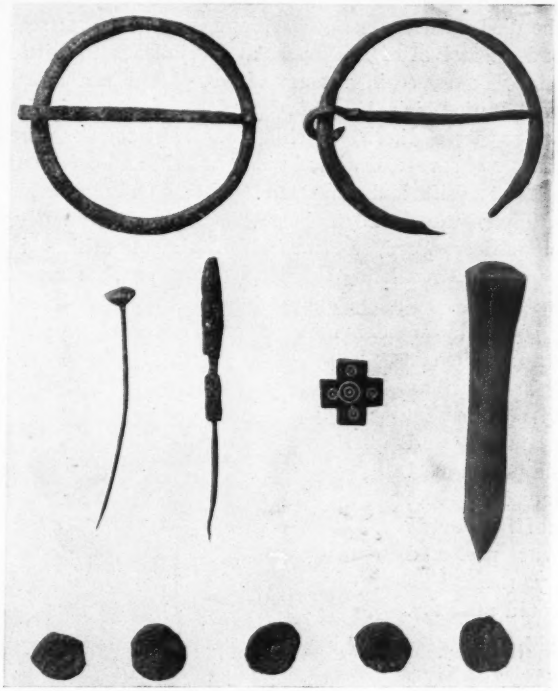
on July 9th the first coffin, and on the 11th the first costume. "The special conditions of the excavations," writes Dr. Norlund, "necessitated the invention of special methods for the exhumation and conserving of the finds, particularly the woven materials. They all lay directly in the earth, and would hardly bear touching in their saturated, recently-thawed condition. Sometimes the earth could be rinsed away, sometimes it had to be removed with a shovel. In certain cases the uncovering of an entire costume took a whole day's persistent work. The costume once uncovered, it had to be taken up, and that was an even more difficult task. The wet material was just as heavy as it was frail, and could not carry its own weight. It was necessary to push something under it to serve as a substratum. The best and most cautious method, as experience proved, was to unroll sacking under the costume and lift it thereon.

Preservation Methods.

"The next difficulty was the keeping of the costumes. It was the middle of summer, and not until the autumn could we expect to be in Copenhagen. There could be no question of any actual conservation on the spot. I tried to clean the earth off the material by rinsing it thoroughly, but it could not be done. I tried drying it slowly, but then the threads burst and crumbled away. The only thing to be done was to keep the material in the same damp condition in which it was found.

"We had brought with us three large tin boxes in which we had intended to deposit the finds for fear the damp and salt of the ship's hold should affect them. But with objects of this kind and in this condition damp would be no danger. Quite apart from the fact that the tin boxes could not hold the very numerous objects, they proved quite unsuitable.

"The tin boxes being useless we had to send to the nearest settlement for boards from which we made up cases adapted to the size of the costumes. But how were we to pack them so that they lay firm and could not dry? And we had to deal not only with the costumes, but with the numerous wooden objects that came to light, and would split if they began to dry. It was a serious problem. Grass, heather, and seaweed were found to be unsuitable, and then our difficulties were fortunately solved. The beds of the little rivers carrying the melted snow down the mountain side were overgrown with very thick saturated moss, which could be peeled off in large flakes. This moss possessed the properties we required. It was firm, yet soft, and very slow-drying, and it was present in quantities. When the objects were temporarily laid on the grass, we covered them with it, and later on we used it as a packing material in the cases. Thanks to this, on unpacking we found all the objects in exactly the same conditions in which they were laid down, despite the fact that three months had passed between the dispatch of the cases from Herjolfsnes and their arrival in Copenhagen."



MISCELLANEOUS ARTICLES FOUND IN THE NORSE CHURCHYARD AT HERJOLFSNES.
Above are shown two brooches of brass formed of a thin circular ring with a thorn attached. Below this are two pins of copper, a pendant cross of bone, and a wooden peg. At the bottom of the photograph are shown five buttons from the sleeve of a man's dress.

Burial Finds.

Twenty-nine coffins were exhumed, but they did not yield so much as a shroud or even a piece of bone, being simply full of earth. Yet it was in the coffins that the more valuable crosses were found, where they were laid on the breasts of the dead. They are perhaps the most interesting part of the grave furniture, the collection totalling over fifty. They vary considerably in quality, shape, and design. Some are elaborately carved and inscribed with the name of the deceased and some religious quotation. In one coffin was found a little carved stick with the following inscription in the Norse tongue: "This woman was laid overboard in the Greenland Sea, who was named Gudweg," the inference being that

she died on the way to Greenland, was buried at sea, and on arrival of the vessel at Herjolfsnes the little stick was carved in memory of her, placed in a coffin, and buried in the churchyard. Thirteen of the coffins were those of children. The coffins were mainly of spruce, deal, red pine or larch, and consisted of both drift and imported timber. Only a single specimen was found to be of native growth, namely, of juniper wood, a tree which still flourishes in Southern Greenland, though inclined to be stunted in growth. While some of the coffins were joined together by wooden nails, in others whalebone fibre was employed.

The distribution of the coffins and shrouds would indicate that coffin-burial was preferred by those who could afford it.

Shrouds.

For the most part the coffins were found closely packed round the walls of the church where the most coveted burial-places were. In the out-of-the-way corners of the churchyard there were no coffins, but here some of the best-preserved shrouds were found. These shrouds consisted of genuine articles of clothing, sometimes complete, sometimes mere fragments, but rarely so fragmentary that their use could not be determined. There were dresses, hose, hoods and caps. Then the clothing was not made for the dead, but was worn by them when still alive. Hence they bear marks of wear and, indeed, many of them are quite threadbare and patched with big patches. Mending was done by means of patching, darning as a means of repairing being evidently unknown. All the costumes are of woven material and from tests made would appear to be entirely of sheep's wool. The thread is nearly always simply twisted.

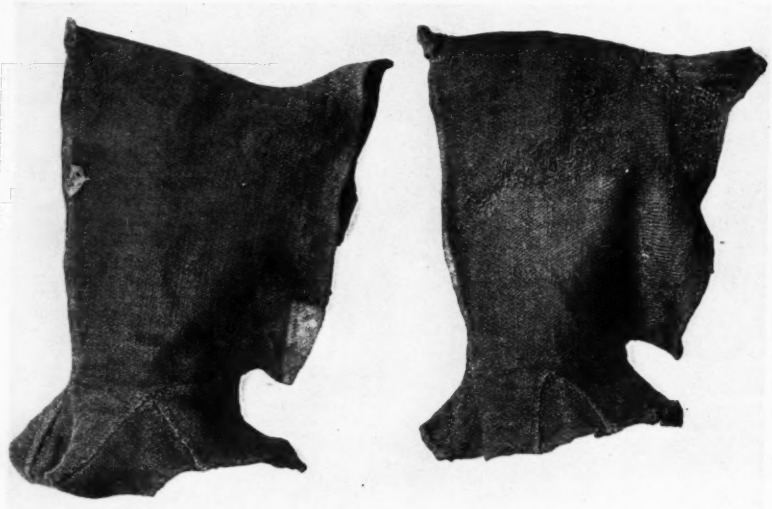
It was only in the shrouds that any skeletons were found, and some twenty-five were brought to Copenhagen. They were in a very poor and exceedingly fragmentary condition, and at first sight appeared to be hopelessly damaged. Thanks to the skill and initiative of Dr. C. C. Hansen, Professor of Anatomy at the Museum, they were cleansed, sorted, and subjected to minute microscopical examination, with the most interesting results.

The task of conserving the relics was a protracted one. The wooden objects were treated with alum or glycerine. The various articles of clothing were first immersed in water, lying on the sacking on which they had been taken up. Here they remained for some days in order to dissolve the various foreign substances that had become entangled among the threads, such as root-fibres, and especially deposits from the decayed body clinging to the material. After

Cleaning.

the rinsing was finished the stuff was slowly dried, and was then subjected to a kind of massage cure, being laid on a table and then treated with the fingertips to remove all foreign particles. This was the most important part of the conservation work, and also the most troublesome part, and when it was accomplished the material had regained its old elasticity and, in an astonishing degree, its original strength. A backing of tulle was affixed to the more dilapidated parts, whereupon all the material was treated with a beticol preparation. The restoring of the costumes to their original shape was now carried out by Miss Signe Wygdal, deputy keeper at "Dansk Folkemuseum," an expert on the early methods of weaving.

The style and cut of many of the costumes would indicate that they are of the fourteenth and fifteenth centuries, clearly showing that the Norsemen were in communication with Europe up to that time.



HOODS FOUND IN THE ANCIENT CHURCHYARD AT HERJOLFSNES.
The first contained skeletal remains of a young man, and the other those of a young woman.

There is certainly geographical and geological evidence to show that it was at this period that a fatal change of climate occurred in these northern latitudes. Whereas Herjolfsnes and the adjoining fjords were free of ice all through the summer, they suddenly became blocked virtually all through the year, rendering navigation exceedingly precarious if not impossible. It was at this period too that a gradual decline of shipping in Norway took place, while not least we must not forget that the King of Norway had sold to a single firm of merchants in Bergen the exclusive rights of trading with Greenland, and made it a statutory crime for the colonists to build and sail their own ships or to deal with anyone not connected with this firm. This decline of shipping, coupled with the unexpected presence of ice at midsummer, meant, no doubt, that attempts to keep in touch with the settlements were gradually given up and then ceased altogether.

Climatic Changes.

When the Norsemen settled in Greenland there were no Eskimos there, though they found remains of their dwellings. They had retreated northward, following the ice on which they hunted seals, their principal item of food. When the ice came south they poured down upon the colonists and there are records of encounters between them. Being cut off from Europe on which they had learned to depend for many essentials to their existence, and being called upon to face a terribly rigorous and hard climate, they gradually deteriorated in physique. This is evidenced as a result of an examination of the skeletons. They were of short stature, especially the women, many of whom could not have borne children *per vias naturales* through pelvic deformities. Constitutionally they were a weak and declining race, brought about no doubt by a long period of undernourishment. This may have been due to the loss of their cattle and their inability to obtain flour from Europe for making their bread. Not only were they small of stature, but from an examination of the skeletons many of them had diseases involving physical deformities such as the weakening of one arm, or one leg, and even in some cases the trunk of the body. There are also distinct traces of tuberculosis of the vertebral column in some of the skeletons examined. Against the Eskimos, so brilliantly adapted to the Arctic conditions, the physically weakened Norsemen could not hold out, and their doom was sealed by the Greenland ice.

Humble Bees: Their Nests and Cuckoos.

By Dr. R. Stewart MacDougall.
University of Edinburgh.

The humble bee is common enough, but it is not every Nature student who can identify the different species or their nests. This article may stimulate closer observation next year, for the relationship of the true Queen and the Usurping Queen is still not clear.

" O grumbling, rumbling, tumbling bee
With chain of gold and cape of fur."

THE Humble Bees are social bees belonging to the genus Bombus (Bombos=buzzing or humming). They are, on the whole, favourites, partly because of their attractive coloration, and partly because of their great industry, this being further associated with a comparatively good temper and a general easygoingness in their home-life habits. The Queen, moreover, spends herself in establishing and supervising the nest, and the Drones or Males have the grace to fend for themselves, different from what we find in the hive of the Honey Bee where

" On others' toils in pampered leisure thrive
The lazy fathers of the industrious hive."

With the Humble Bees there is no accumulation of winter stores, and by the end of the season—the date varies with different species—all the inmates of the nest have died except the young Queens of the year. These young Queens soon after being reared leave the nest and, after being fertilized, prepare a shelter place in which to pass the winter in a dormant condition.

Waking up, in the next year, from her long sleep the Queen searches out a place for a nest. She may discover one ready to hand in the deserted nest of a field-mouse, or she may repair such a nest or may make one *ab initio* from dried grass and moss. The Queen crawls into this little heap of arranged plant material and makes a little cavity in its centre. Here, on the floor, is placed a lump of mixed honey and pollen—collected by the Queen herself—and on it is reared a wall of wax. The wax is an excretion from her own body. In the chamber so formed the Queen

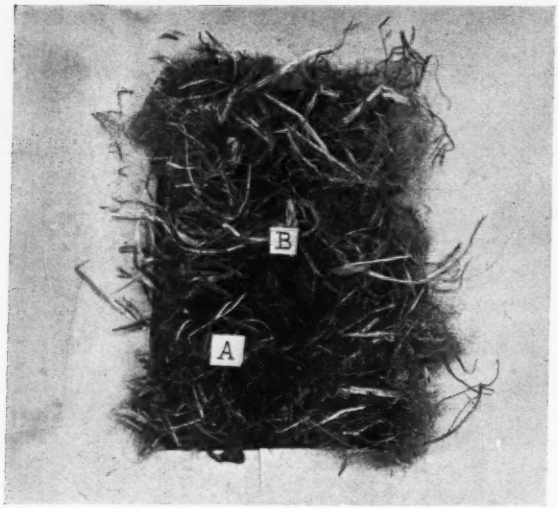


FIG. 1.
BEGINNING OF NEST OF BOMBUS DERHAMELLUS.
(*A*) First bunch of larvae; (*B*) Honey-pot.
(Natural size. From Nature.)

lays a batch of eggs and then closes up the chamber. The Queen sits on her eggs. Close by and within her reach she has constructed a honey-pot, and on the honey in this pot the Queen can nourish herself while she remains in the nest to incubate her eggs or while she is compulsorily kept indoors by unfavourable weather (Fig. 1).

Birth of the Grubs.

The eggs hatch in four days or so. The grubs are curled, legless, and cream-white; they begin to feed on the lump of mixed pollen and honey. As the grubs develop they are fed by the Queen who, for the purpose, nibbles a hole in the waxen wall and squirts inside a mixture of disgorged honey and a little pollen; the hole is then closed up again. As the grubs increase in size they are fed individually by the Queen through openings made for the purpose. The grubs typically remain under cover of the wax, invisible from the outside. As they grow the Queen adds more wax, repairing cracks that result from the increase in their size. Bulges show in the waxen cell corresponding to the position of individual grubs. By a fortnight, in favourable conditions, the grubs are full-grown, when each makes for itself a thin but tough yellowish cocoon, under cover of which pupation takes place. As the wax is removed the cocoons are revealed standing up on their ends. On these cocoons the Queen stretches herself, furthering development by the heat of her body. The new bees are ready in from three to four weeks from the laying of the eggs. The new young bees are all Workers; they soon attain their characteristic coat and colours, and in three or four days are out foraging. The Queen lays other batches of eggs in wax cells placed on the cocoons, and so on, and as soon as workers enough have been reared she ceases to go out and collect, devoting herself to egg-laying and the rearing of brood. As the colony increases in size honey and pollen stores are found in the nest. The honey is placed in old cleared-out cocoons, and in specially made waxen honey-pots, and the pollen in special cells.

The Royal Family.

As the season advances Males or Drones, and young Queens are reared. These young Queens leave the nest and after fertilization go into winter quarters. The Drones leave the nest and, according to Sladen, do not return. This is the usual thing, but Wild * has found that in exceptional circumstances they may return for shelter. Later the Workers that are left die, the old Queen dies, and the nest comes to an end.

Fig. 2 is a photograph of a nest of Bombus lapidarius in my possession. It was dug at Cheltenham from a depth of two feet, and had an entrance tunnel of eighteen inches (a short tunnel for this species). Nearly all the cocoons at the time the nest was taken (end of first week of August, 1923, after an unfavourable

* "Observations on the Humble Bees of Bute," by Oliver H. Wild, M.B., Ch.B., in the *Scottish Naturalist*, March-April, 1924.

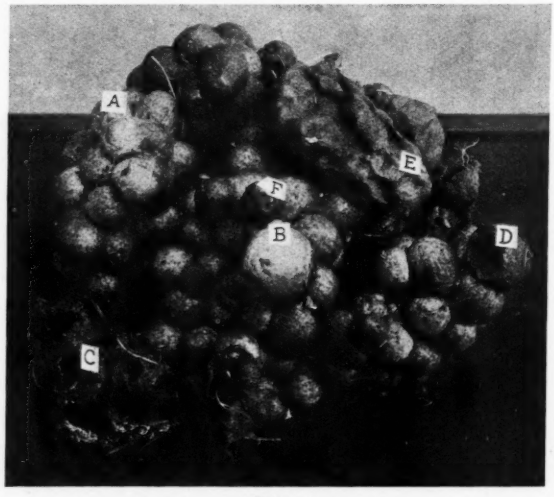


FIG. 2.
NEST OF BOMBUS LAPIDARIUS.
(*A*) Worker cocoons (*B*) Queen or Drone cocoons; (*C*) Honey pots; (*D*) Empty cocoon—probably Drone; (*E*) A bunch of Drone brood; (*F*) Bunch of larvae.
(Natural size. From Nature.)

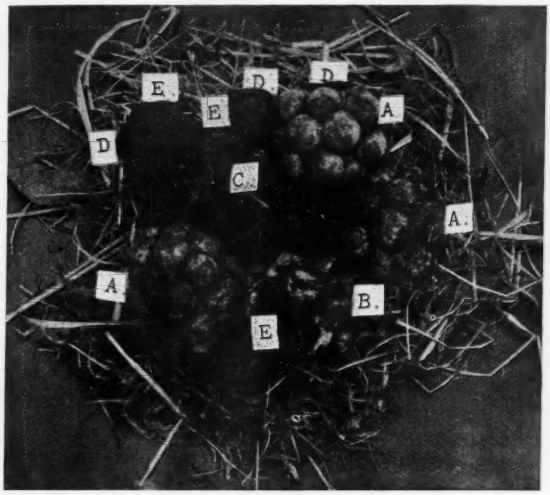


FIG. 3.
NEST OF BOMBUS AGRORUM.
(*A*) Worker cocoons; (*B*) Empty Worker cocoons; (*C*) Old cocoons containing honey; (*D*) Pollen-pockets; (*E*) Bunch of larvae.
(Natural size. From Nature.)

season) were Worker cocoons. The cocoon marked D—probably a Drone cocoon—was being used for storing pollen.

The foregoing life history and description is a general one, but there are variations in habit and behaviour. For example, in the nests of Bombus agrorum and Bombus muscorum the pollen, instead of being stored in cells at a distance from the larvae, is found in saucer-like projections from, or attached to, the bunches of larval brood. In this position the pollen seems within reach of the feeding larvae as in D of Fig. 3 and E of Fig. 4.

Nest Details.

Bombus agrorum and Bombus muscorum are generally distributed in Britain. Both are more or less yellow or tawny coloured. Bombus agrorum is on the average smaller than Bombus muscorum; its thorax is bright tawny yellow and black hairs may show amid the yellow; abdomen pale-yellow next the thorax, black in the middle and tawny at the tail.* In muscorum the thorax is orange-brown and never has black hairs; the abdomen is yellow with brown bands. In both species the nest is on the surface (Figs. 3 and 4).

The nests of surface nest-makers are often quite hidden by herbage, and that of Bombus muscorum in Fig. 4, taken on the last day of July, was nine inches below the surface, and approached by a tunnel a foot in length. The Queen, a few Drones, and thirty-four Workers were present. For the purpose of the photograph the Queen and some Workers were placed on the nest. One of these Workers is a dwarf one. If we examine carefully nests of Humble Bees, variations in size of Worker are found. Sometimes dwarfed forms are present towards the close of the season, the dwarfing being due to unfavourable food conditions. Even during a normal period different sizes of Workers are found—larger ones that go out and collect, and smaller ones that do indoor work as nurses.

Usurper Humble Bees or "Cuckoos."

Some of the Humble Bees have an enemy in the form of a Usurper Bee, the Usurper having a resemblance to the Humble Bee species which it parasitizes. The Usurper or Cuckoo Queen enters the nest of the Humble Bee and after a time kills the Queen. The usurping Queen then takes possession, lays her eggs,

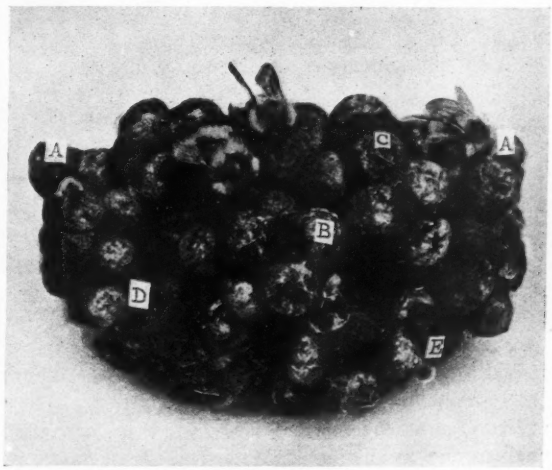


FIG. 4.
NEST OF BOMBUS MUSCORUM.
(*A*) Worker cocoons; (*B*) Drone cocoons; (*C*) Queen brood; (*D*) Honey-pots (*E*) Larval mass with pollen-pocket.
(Natural size. From Nature.)

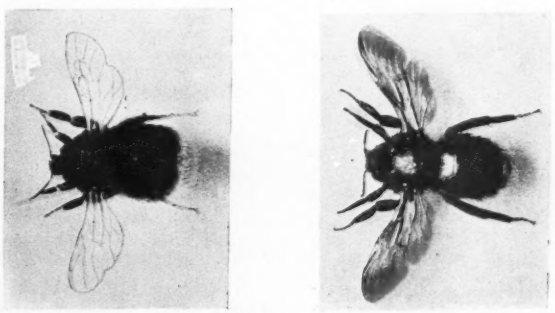


FIG. 5.
QUEEN OF BOMBUS LAPIDARIUS AND QUEEN OF PSITHYRUS RUPESTRIS.
(Natural size.)

* "The Humble Bee," by F. W. L. Sladen.

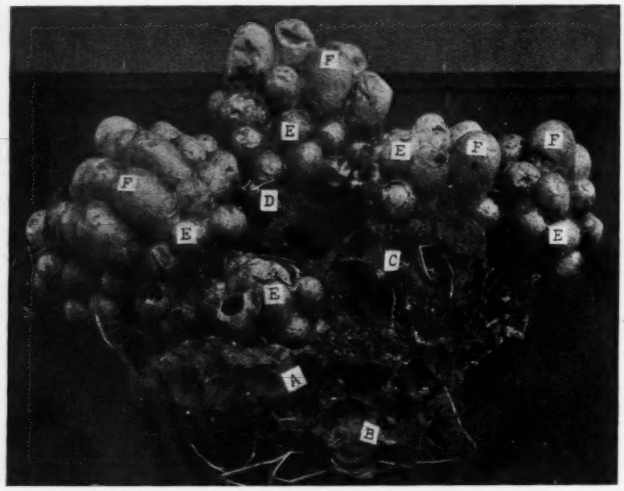


FIG. 6.
NEST OF BOMBUS LAPIDARIUS USURPED BY PSITHYRUS RUPESTRIS.
(*A*) Enclosed brood of Usurper Queen; (*B*) Waxen honey-pots; (*C*) Old lapidarius cocoon used for storing pollen; (*D*) Empty lapidarius cocoons; (*E*) Drone cocoons of Usurper; (*F*) Young Queen coccons of Usurper.
(From Nature; very slightly enlarged.)

and her brood is reared by the Workers of the killed Queen. In the Humble Bee community there are three castes—Males, Queens, and Workers—but there is no Worker caste in the case of the Cuckoo Bees, only Males and Queens; all the necessary worker functions are performed by the Workers of the usurped nest. The generic name of the Usurper Bees is Psithyrus, a word which means whisperer or twitterer; the sneaks have a lower softer hum.

While the Usurper Psithyrus rather closely mimics the Humble Bee in whose nest it is parasitic (Fig. 5), a little experience, with observation in the open, enables one to distinguish the two. Here are some helpful differences as regards the Queens:

BOMBUS.	PSITHYRUS.
More active on the wing, and generally the wings are lighter in appearance.	Somewhat awkward in comparison, and lethargic; wings darker (especially in the Queens).
The wings vibrate more rapidly in flight, and so the hum is louder, and higher in pitch.	Hum softer and pitch lower.
More furry.	Not so furry and therefore the abdomen seems more shiny or at any rate shows unclothed areas. Abdomen rather more slender.
Body not so hard and protected.	The Queens have the skin thick and hard, and the joints of the abdomen are so close that chinks are not left through which a sting can be thrust.
Sting weaker.	Sting more curved and stouter.
The Queens and Workers have a pollen carrier, known as the corbicula. This is the outer surface of the tibia of the hind legs; this outer surface is concave, smooth, and bare, with long stiff hairs along the two edges of the tibia.	No pollen carrier, as the Psithyrus Queens do not collect. The outer side of the hind tibiae is not shining, but the whole surface is convex and covered with short hair.

The earlier opinion was that the Psithyrus Bees lived in the nest of the Humble Bee, doing no more harm than feeding at the expense of the Bombus stores. Sladen proved the parasitic nature of such species as he had opportunity to observe. To follow Sladen's account, the

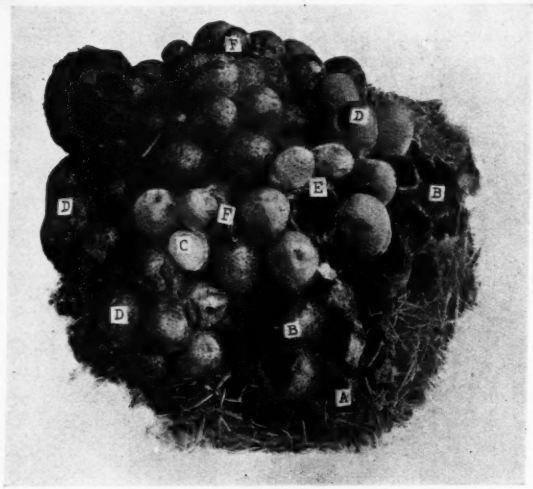


FIG. 7.
NEST OF BOMBUS LAPIDARIUS USURPED BY PSITHYRUS RUPESTRIS.
(*A*) Empty Worker cocoons of Bombus lapidarius; (*B*) Empty Usurper cocoons; (*C*) Drone cocoons of Psithyrus rupestris; (*D*) Queen cocoons of Psithyrus rupestris; (*E*) Empty Queen cocoon of Psithyrus rupestris; (*F*) Bunch of larvae of Psithyrus rupestris.
(From Nature; one-tenth over natural size.)

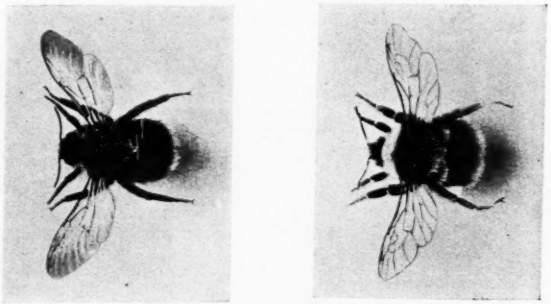


FIG. 8.
QUEEN OF BOMBUS HORTORUM AND QUEEN OF PSITHYRUS BARBUTELLUS.
(Natural size.)

Psithyrus Queens come out from their winter shelter places somewhat later than the Bombus Queens, and the Psithyrus Queen enters a Bombus nest at a time when the number of Bombus Workers is small. The Usurper displays no aggressiveness at first, tries indeed to be as unobtrusive as possible, and remains unmolested for a time. The Bombus Queen may even grow accustomed to the presence of the Usurping Queen. But, as Sladen writes, "While the alarm of the Bombus Queen disappears it is succeeded by a kind of despondency.

A Duel.

Her interest and her pleasure in her brood seem less, and so depressed is she that one can fancy she has a presentiment of the fate that awaits her. It is by no means a cheerful family, and the gloom of impending disaster seems to hang over it." In due course the number of Bombus Workers in the nest increases, and gradually the Psithyrus Cuckoo, who has been trying to win popularity among the Workers, shows increasing interest and activity, and prepares to lay her eggs. This enrages the Bombus Queen, and a fight takes place which, owing to the mailed armour of the Psithyrus Queen—unless she gets it in the neck which, as an Irishman would say, is her Achilles' heel—results in the death of the Bombus Queen and such Workers as may have gone to her assistance. "Psithyrus is not only a mistress of the crime of murder, but also knows how to commit it at the most advantageous time for herself and her future children." The Usurper continues her egg-laying and when the eggs have hatched the brood is fed and tended by the "orphan children of the late Queen." Psithyrus Males and Queens are reared, and these young Queens, after being fertilized, seek shelter or winter quarters in the same way as described for the young Bombus Queens.

Bombus lapidarius (Fig. 5) is a common species easy to recognize by its large size, black colour and red tail. Bombus derhamellus is also black with a red tail, but the red is dingier and the bee is smaller. Bombus lapponicus has not only the tail, but nearly all the abdomen red.

The Cuckoo of Bombus lapidarius is Psithyrus rupestris (Fig. 5). This Cuckoo, as one would expect, is also black with a red tail, but the features of a Psithyrus are distinct; the brown or dark wings at once pick out the Cuckoo.

Figure 6 is a photograph from nature of the nest of Bombus lapidarius usurped by Psithyrus rupestris. The nest was dug out on 14th August from a depth of two feet four inches, with an entrance tunnel of six feet. When dug and examined, the nest revealed

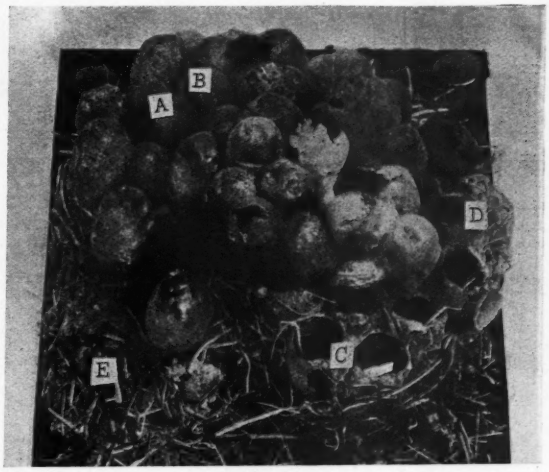


FIG. 9.
NEST OF BOMBUS HORTORUM USURPED BY PSITHYRUS BARBUTELLUS.
(Natural size. From Nature.)
(*A*) Wax and pollen masses with eggs and larvae; (*B*) Queen cocoons of Usurper; (*C*) Empty Queen cocoons of Usurper; (*D*) Empty Drone cocoons of Usurper. (*E*) Empty Worker cocoons of Bombus hortorum.

the killed foundress Bombus Queen, and thirty-six of her Workers; also the active Queen Usurper, five young Psithyrus rupestris Queens and twelve new Male or Drone Psithyrus rupestris.

Figure 7 is another nest of Bombus lapidarius usurped by Psithyrus rupestris. The nest came to me from Dr. Oliver Wild, and is the best I have seen. When dug, the killed foundress Queen was found lying dead in the entrance tunnel to the nest; there were also fifty lapidarius Workers and the usurping Queen.

Alien Invasions.

An interesting difference is met with in connection with Bombus hortorum and its Cuckoo Psithyrus barbutellus (Fig. 8). Bombus hortorum is a common bee, with an underground nest. It is middle-sized, the Queen measuring from $\frac{3}{4}$ in. to $\frac{4}{5}$ in. long. The colour is black with yellow bands on the thorax; while the abdomen has yellow, white, and black segments.

A nest of Bombus hortorum parasitized by Psithyrus barbutellus is seen in Fig. 9. This nest was dug on 6th August. In it were present the Queen-foundress Bombus hortorum *alive*, and twenty hortorum Workers; also the Queen Usurper, Psithyrus barbutellus, three young usurping Queens, and seven Drones of the Usurper. It is very interesting to note the fact that the foundress Queen was still alive in spite of the active presence of the egg-laying Usurper Queen. Dr. Wild, in answer to my queries, assures me that this is not exceptional with hortorum whose

(*Continued on page* 440.)

High-Velocity Photograp

By "Ballisticus."

Exposures of two millionths of a second characterize these astor
in flight at 800 feet per sec

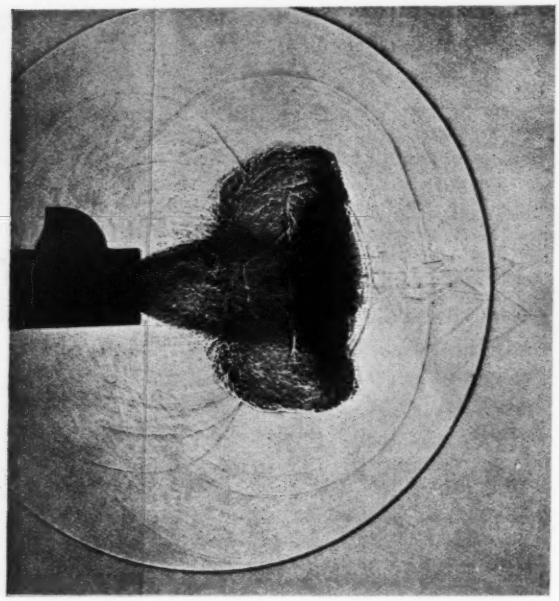


FIG 1.
NOTE THE RING-SHAPED ADVANCE GUARD OF AIR AND LEAKAGE GASES, ALSO THE SMALL PARTICLES OF POWDER RESIDUE.
Each of these has its wave and waves, the slope of the latter being indicative of their speed. The big ring is the sound wave, and it can be seen that in some cases particles have passed it.

ONE of the most interesting of the scientific applications of photography is the use of a spark to take pictures of bullets in flight at extremely high velocities. The first spark photographs were taken at Prague as long ago as 1881, but it was not until Professor Boys introduced new methods in 1893 that the photographs showed also the sound wave and other air disturbances produced by the projectile. These show as shadows, as their refractive indices differ from that of the surrounding air.

In these early devices the bullet itself acted as a switch. It either cut wires or passed through a diaphragm of paper. These methods inevitably caused some slight distortion of the emergent gas waves. Recently Mr. Philip Quayle, Assistant Physicist of the U.S. Bureau of Standards, has improved the spark photography mechanism so that a far quicker switch action is attained without the use of the bullet itself as a switch, and without any interfering mechanism in front of the rifle muzzle.

Two systems may be used. In the first an inertia device is fitted to the striker piece of the rifle and adjusted so that the lag is just sufficient to allow the spark to pass when the bullet is at a given spot in front of the photographic plate. In the second, the head wave of sound made by the initial explosion of the cartridge is allowed to impinge on a Joly chronograph interruptor. This is a metal box with a diaphragm across the back of which is an arm holding a taut wire closing an electrical circuit. When a sound wave impinges on the diaphragm the arm or lever is momentarily forced back by the impulse and breaks contact.

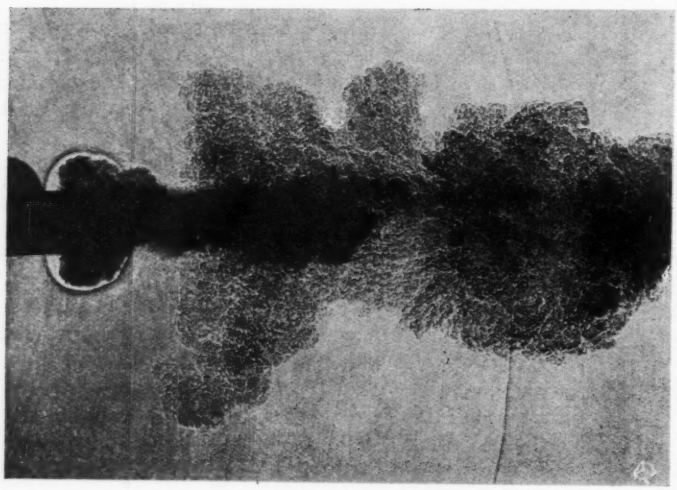


FIG. 2.
THE BULLET HAS NOW EMERGED.
Its base is $\frac{1}{8}$ in. outside the barrel, and the release of gases behind it starts a new sound wave—

Either of these devices may be used to release a trigger switch which is held cocked by a relay device, and which in turn operates a very delicate electrical mechanism which controls the damping of the spark.*

Terrific Speeds.

The modern military rifle has a muzzle velocity of 2,700 feet per second, while special high-velocity weapons may surpass 3,000 feet per second. To get a picture on a plate 8 in. by 10 in. therefore involves an exposure which has to be most accurately timed. The bullet is only in a position to be photographed for 0.0003

* For details see Scientific Paper S. 508, U.S. Bureau of Standards.

Photography of Bullets.

y "Ballisticus."

acterize these astonishingly interesting photographs of a bullet t 800 feet per second.

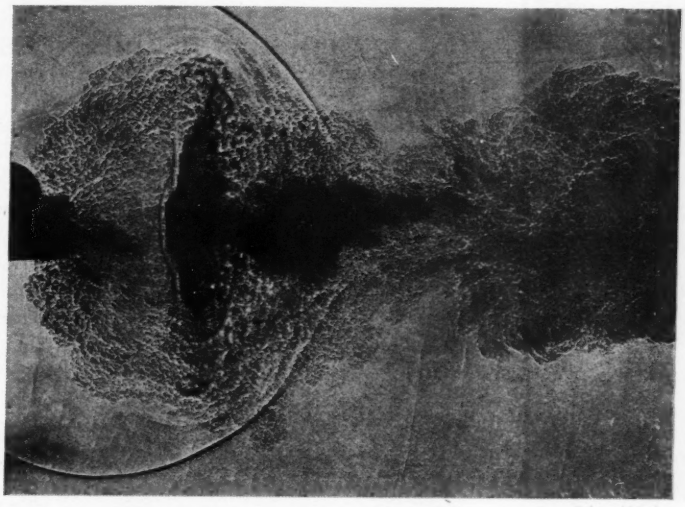


FIG. 3.
THIS SECOND SOUND WAVE NOW EXPANDS.
The bullet is well out of the muzzle and still being accelerated. Gases are impinging on its base and being deflected. Some gas going faster than the bullet has blown through the spherical wave in the centre of the plate.

of a second. If the photograph is to be clear and not show blurring due to motion through more than $\frac{1}{100}$th of an inch while the picture is being taken, the time of exposure must not exceed *two millionths of a second.* The swiftest exposure of the most modern camera shutter used for photography of racing motor-cars, high jumping, etc., is therefore some ten thousand times too long '

The Apparatus.

The system used is to charge a Leyden jar condenser of 0.024 μ farad capacity from an influence machine, and to prevent overcharging by means of a potential limiter. This consists of a pair of discs which are repelled from another similar pair when the stored energy reaches a sufficient pressure. These are arranged to disconnect the Leyden jar system from the influence machine when the former is loaded. They also close a signalling circuit which tells the operator that all is ready. He fires the rifle and if the apparatus is in adjustment the spark from the Leyden jars shoots across an aluminium wire spark gap made rather like an ordianry sparking plug, and produces an intense point of light for the two-millionth part of a second.

Some of the problems which may be solved by this apparatus are of great importance to ballisticians. We have never known exactly whether a bullet gained velocity after it had left the muzzle, or whether retardation began immediately on emergence. Quayle's photographs show very definitely that the bullet deflects the gas wave for some inches in front of the muzzle. This shows that the gases are still acting on the bullet, and that this blast ceases at about ten inches from the muzzle.

The head wave of the bullet, and even of unburnt grains of powder, as well as the sound wave, are shown on the plates, and from the angle of the wave the speed of any of these bodies may be estimated. In some cases powder particles are projected at a higher velocity than the rate of sound. In the revolver photographs the muzzle velocity of the bullet is about 800 feet per second. Sound in air moves at about 1,100 feet per second, and the high velocity given

(*Continued on page* 432).

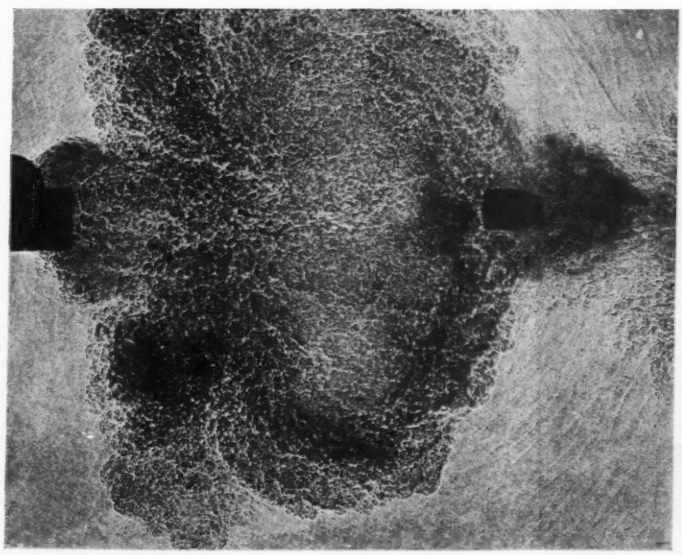


FIG. 4.
HERE THE GASES ARE NO LONGER BEING DEFLECTED BY THE BULLET, HENCE IT IS NO LONGER BEING ACCELERATED.

Electrification that Lasts for Years.

A new discovery which is of considerable scientific interest.

A DISTINGUISHED Japanese physicist, Professor Mototaro Eguchi, of the Higher Naval College at Tokyo, has reported a discovery which promises to have far-reaching effects on electron theory and, quite possibly, on radio technique. He has discovered a way of obtaining what seems to be permanent electrification, analogous to the persistent magnetism of the familiar permanent magnets. Professor Eguchi has named his new invention the "permanent electret."*

How it is Made.

The process of making the electret is quite simple. A liquid mixture of melted wax-like substances is allowed to harden (by cooling) in a strong electric field. The wax plates thus produced are found to be permanently electrified. The wax mixture used in most of the experiments contains fifty per cent. of ordinary resin, presumably from some species of pine tree, mixed with fifty per cent. of carnaüba wax. To this may be added a little beeswax, but this is not essential.

This melted mixture is poured into shallow, flat pans like pie tins. A metal plate is then lowered on to the top of the wax mixture and a strong electrostatic field is created between this metal plate and the metallic bottom of the pan that holds the wax. The source of charge is a vacuum-tube electrostatic generator.

Essentially, the metal pan and the superposed metal plate act as the two plates of a high-voltage condenser. The wax mixture hardens while it forms the dielectric of this condenser; that is, while it is exposed to enormous electrostatic stress. After it is hard the wax plate is found to be electrified in the reverse sense to the electrification of the condenser. One side of the plate is permanently negative, the other side is permanently positive. These charges last for years. Some have lasted since 1919. The voltage reached by this surface charge may be as high as 20,000 volts per centimeter. The density of the charge on one of the plates was measured as six electrostatic units per square centimeter of the surface.

Scraping of the surface, washing it with acids or other conducting solutions, exposing it to the heat of a gas flame and similar processes destroy the surface charge temporarily, but the charge is restored quickly when the electret is allowed to stand with its surface protected by a metal plate or a sheet of metal foil. Professor Eguchi believes that the electrification is due to a fundamental rearrangement of the electrons and atoms inside the wax mixture, an electric "polarization" which extends a substantial distance inward from the surface, if not altogether through the plate. The temporary destruction of the charge by solutions, flames and other agencies is ascribed to an accumulation of oppositely-charged ions on the surface. These annul temporarily the permanent charge of the electret. On standing, the accumulated ions escape and the permanent charge reappears.

It is obvious that these experiments are of the utmost interest from the viewpoint of atomic theory. If they are confirmed, and especially if they can be detected in plates of pure substances instead of in the mixtures actually used, they will indicate the possibility of creating a lattice structure of atoms in which there is a sufficient distortion of the atom (or electron) positions to cause a great lack of balance between the positive and negative charges. This is a new line of attack on the problems of atomic structure.

It will be remembered that about forty-five years ago, when the polariscope and spectroscope were being developed, Dr. Brewster claimed to have made *artificial* crystals by melting together white wax and rosin and letting the mixture set under conditions of strong pressure. His slides so prepared showed double refraction, and rings like those given by a crystal viewed in convergent light.

Possible Applications.

X-ray spectographs recently taken by crystallographers show an unsuspected crystalline structure or lattice in wax mixtures and even Canada Balsam. Many colloidal or amorphous bodies now appear to contain crystal structures whose behaviour under stresses has not yet been investigated.

We cannot say what the electret may lead us to, but it must be remembered that in 1600 the permanent magnet invented by William Gilbert had no apparent use. To-day magnets are indispensable, and a practical application of the electret is by no means outside the range of probabilities.

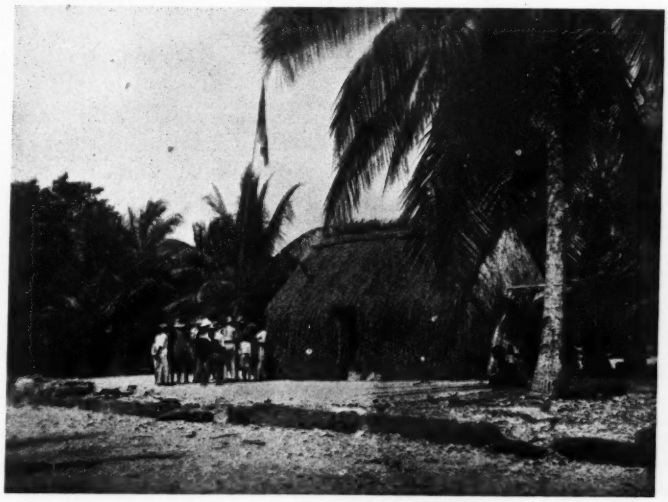
* "On the Permanent Electret," by Mototaro Eguchi. *Philosophical Magazine* (London), vol. 49, pages 178-192 (January, 1925).

The Voyage of the "St. George" to the South Pacific.

The yacht "St. George" was sent out by the Scientific Research Association with a staff of scientists and a few passengers interested in science, leaving Dartmouth on 9th April, 1924. The following short account of the outward voyage is by the Marine Biologist, Dr. Cyril Crossland.

Of the scientific staff on board the "St. George" two had had experience of Malaysia, one of these of West Africa also, one of India and Ceylon, the present writer of East Africa, the Cape Verde Islands, the Red Sea, Egypt and Palestine, yet the climates, faunas and floras, and peoples met with on this cruise were, in many ways, quite novel to us all.

Our first stop in the West was at Trinidad, where in the staff of the College of Tropical Agriculture we found congenial and very kind friends, so that our recollections of the island are among the pleasantest of the voyage; though, of course, mere callers as we were we could do little, the experience and help of resident experts was of the greatest value to the land workers.



A GRASS HUT ON A CORAL ISLAND.

Finds.

In marine biology the results were small but interesting. The whole sea is smothered in the mud of that vast river, the Orinoco, even at this distance from its mouths, the bottom being of butter-like consistency. However, creatures adapted to so unfavourable a habitat were found in greater variety than expected. Notable was a cockle which avoided smothering in mud by acquiring the ability to swim, and that vigorously. The foot, the normal function of which is to dig into the mud, is enlarged and flattened, and forms a swimming organ comparable in proportionate size and action to the tail of a tadpole. Specimens placed in a deep jar can swim to the surface and round and round before falling to the bottom again.

Another form is the well-known worm *Panthalis*, which forms an almost gelatinous tube in which it lives. The species found here are very beautiful, the dorsal scales being primrose yellow edged with black. We obtained the same species at Colon, the Atlantic entrance to the Panama Canal, but on the Pacific side another *Panthalis* was taken, with a different colouration of the scales. Apparently a beautiful example of the distinctness of the faunas of the Atlantic and Pacific sides of the isthmus, it later turned out to be a beautiful example of the danger of drawing conclusions in geographical distribution from small collections, as the Atlantic species was soon found also on the Pacific side.

Nereis.

The little pink or green worm *Nereis dumerilii* again was captured at Dartmouth before the expedition sailed and subsequently at, I think, every locality at which we touched, including Tahiti. It is not to be inferred that no definite geographical distribution of species is to be found among marine species. This is far from being the case; the above examples are given as instances of the difficulty and the complication of the problem in the case of an ancient group like the marine polychaet worms.

The climate of Panama is unlike anything I imagined possible in the tropics. The sky is generally cloudy, one rarely sees the sun even when it is not raining. It cannot be called at all hot, though the perpetual damp is trying, especially on board ship. Consequently the ways of life of the "Canal Zoners" seem strange to one used to India and the East. The presence of white women and children in normal numbers, their dispensing with hats and tropical gear generally, their appearance of health and energy, make one feel that one cannot really be as near the Equator as the

map declares. The "Zone" has been fortunate not only in Colonel Goorgas' conquest of malaria and yellow fever, but in its freedom from that Indian tradition which prescribes so many uncomfortable and positively harmful "health precautions" upon the European dwellers in the tropics. Panama is also a region of almost perpetual calm. The "sailing directions" warn mariners that the crossing of the Gulf without the aid of steam is one of the most trying passages a sailor is likely to experience. We found it so. In sight of land for days: our long-awaited letters, our friends ashore, as good as three hundred miles away. That this condition is perennial is shown by the accumulation of "almost unbelievable mud" (to quote Agassiz) over practically the whole sea bottom, which is largely composed of organic matter from the forests and rivers of Central America.

Gorgona Island.

At Old Panama even the shore between tide levels is of a mud so thin that it splashes when a stone is thrown into it, there not being waves enough, in a quite open bay, to prevent its accumulation. Perhaps this is the reason why the site was abandoned after the sack of the city by that Welsh blackguard Morgan. Fishing boats, again, have masts as slender as broom-sticks, and calico sails rotten and patched beyond belief. This *is* the Pacific Sea, though for the Ocean "Pacific" is a well-known misnomer.

In this region we explored the Perlas, Gorgona, Coiba and Taboga Islands, besides many excursions on the mainland. At the first the weather was so terribly rainy and the bush so uncomfortable that our stay was short, and I fancy our experience there was a reason, probably subconscious, for not returning. Gorgona is an uninhabited island off the coast of Columbia (South America) covered to its summit with its original forest but for two small cocoanut plantations, worked, or neglected, by visitors from the mainland. I did not find the marine biology here very interesting, after the rich collecting at Panama, but it was my first sight of an untouched South American forest with its epiphytes and tree ferns, and therefore memorable. Land workers found it indeed a happy hunting ground, and were so in love with the place that we paid it three visits, new insects and plants being obtained to the last. The other islands were on the whole similar, except Taboga, which is a little island about nine miles out in Panama Bay—*not* in the West Indies—a very charming little island, but too much cultivated for land naturalists. I added a good deal to the marine collections here; I recall particularly several of the usually rare Chaetopteridae among the worms.

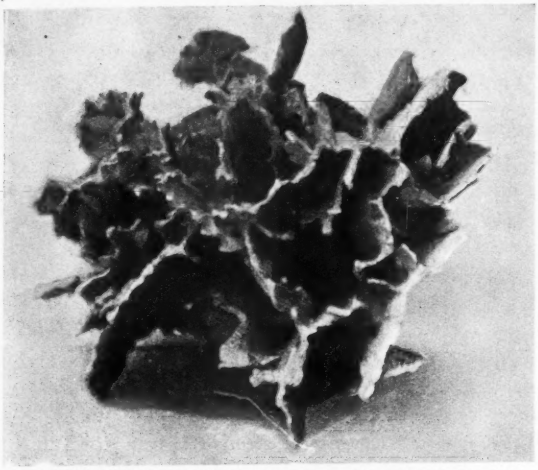
Among so many beautiful and novel sights that of the humming birds remains prominent in memory. There is a water trough on the hillside which these most strange and lovely creatures frequent to drink and bathe. Six or eight might be there at a time, but so ceaseless and rapid are their movements that the air seemed full of their iridescent flashing green. Within a yard or two of us they would dip into the outflow, hovering with wings invisible through the rapidity of their movement, hover a moment and flash away; or they would dip into the strongly flowing outfall, dash the water over themselves, and away to rest and dry on a branch, the only times when their restlessness ceased for a few moments. In the same trough lives a small frog which blows out its throat like a bubble nearly half the size of its body when it croaks.

We had a memorable fortnight in the Galapagos before leaving for the South Seas, an intensely interesting time which everyone would have liked to prolong had that been possible. The change from the dull skies and humid airs of Panama to the sunshine and invigorating dryness of the Galapagos was itself a joy, and though the main interests of the fauna and flora have been long well known, the actual sight of them is a privilege which no one with the least interest in nature would ever forget.

Wonderful Islands.

The scenery of these islands is always stern, sometimes grandly, sometimes monotonously, often fantastically. The view of the great volcanoes of Albemarle, for instance, is tame, dullness itself, until one remembers what they are, the great flat cups which once poured out ashes in quantities the human imagination can hardly grasp, or filled with molten lava which flooded whole islands. Remembering, too, that they may yet break out into their old incredible energy the giants do not lose their dignity in repose. Big cones and little cones, whole and fresh as though made yesterday, or so broken as to be hardly recognizable; cliffs like burnt-out furnaces or cities destroyed by fire, others like iced cakes or children's sand castles; great lava flows that at a distance look like heathery peat bogs; the stony desert but lately cooled from the heat at which rocks are molten, recalling the old old hills at home covered with their wet blankets of fern and sod and heather.

To the marine biologist the distribution of coral in the Panama region is of particular interest, the sea being at the equator but, in contrast to the Atlantic, having no reefs of any extent. Near Colon we saw a little "coral reef," but though the edge was covered



A FINE SPECIMEN FROM THE "ST. GEORGE" EXPEDITION NOW AWAITING IDENTIFICATION AND CLASSIFICATION.

with stony seaweeds and some millipores, and was fissured in the way usual in Pacific reefs, it was clearly a remnant undergoing degradation and not growth. We were not at Colon long enough for much exploration, but that numerous species of coral grow there, or not far away, was shown by a dump of dredged material near the docks. On the Pacific side practically the only corals are one or two species of the genus *Pocillopora* in shallow water near shore, though at Coiba is a flat of dead *Porites*, and I saw a large living colony of *Pavona*. There are no reefs properly so-called, and but for the perpetual calms of this region such flats as there are could not exist, they would be all thrown up on to the beach by the first strong wind.

Sea Fans and Zoophytes.

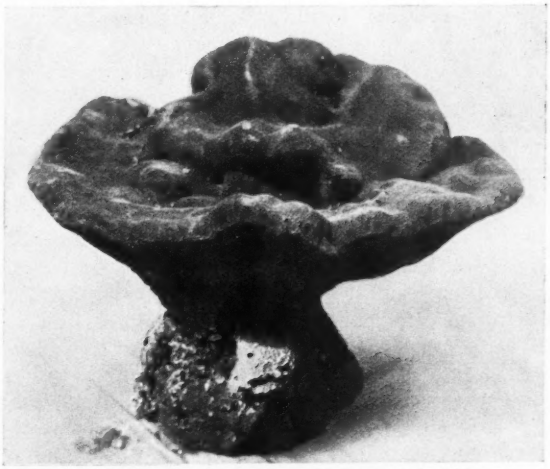
Even in the Galapagos, away from the mud of Central America, coral is just as rare, though Mr. Hornell found beaches with quite considerable quantities of coral fragments, not only of the usual *Pocillopora*, but some of the more solid Astreans as well.

The shore and shallow water in these islands is beautifully rich. Particularly I remember a bed of peat on the shore, submerged at high tide and extending below the level of low water at springs, which was full of Polychaete worms of many species, and some lovely pools among the black rocks of the lava flows. In Tagus Cove the shadow of a great rock sheltered a real sea garden, a shelf of rock just below the water being covered with "sea fans," masses of bright vermilion which were the colonies of the tubes of the minute flower-like worm *Filigrana*; at a touch the worms instantly retreat, and the vermilion disappears, leaving the mass white, the colour of the worms' tubes. Sponges of blue and other colours, polyzoan and hydroid zoophytes, all making a sight of entrancing beauty.

These "sea fans" (gorgonid alcyonaria), interested me especially, as in all my former expeditions I had never seen them between tide marks and had only dredged them very rarely, though their allies, the soft and fleshy alcyonaria, were in the greatest abundance and large variety of genera in both East Africa and the Red Sea, as they are generally in tropic waters. At Panama about six different species live in tide pools, often almost opaque with mud, but there are none of the soft forms. In the South Pacific

Few Alcyonaria.

I have seen three, and only three species of soft alcyonaria, and those only on the reef edge of Tahiti, and no gorgonids at all. Is this a puzzle of geographical distribution, or is it a phenomenon of ecology?



A SPECIMEN FROM A ROCK REEF IN THE PACIFIC.
[*Photo, Scientific Expeditionary Research Association*

It was at Tagus Cove also that we found marine spiders, building their air-filled webs in the empty shells of a large barnacle near the level of the lowest tides. Having found a species of this genus (*Desis*) among coral below the low-tide level near Zanzibar over twenty years ago, and having failed to find it again in the interval, I was particularly pleased with the discovery.

Cocos Island remains quite the most romantic of all our memory pictures, even though we have since seen the more famous islands of the South Seas. Sheer cliffs rising directly from the sea, crowned

with palms and often covered for a hundred feet or more by convolvulus, pierced with caves, one of which we entered by boat, passing through a dark and narrow passage right into the next bay. What hiding places for the pirate treasure which is indubitably there and will be, one fancies, the last of all buried or sunken treasure to be brought to the surface of land or sea. Water falls over the cliffs, so high and sheer, that the solid stream waves like a lock of white hair in the wind, and reaches the beach as a mere mist. A little river at the head of the cove peacefully lovely in contrast to the wild beauty of the cliffs. But it rained and it rained, and there was no solid ground but the bare rock, so that camping was impossible without risk to health. The loveliest place on earth, but how inhospitable !

Problems of Coral Fauna.

The Marquesan Islands are volcanic like the Galapagos, but in all but their origin as complete a contrast as could be. Mere remnants, showing no obvious volcanic features at all, only prolonged geological research could determine the whereabouts of the original craters and positions and heights of the cones and lava flows, which once formed islands several times the sizes of those now remaining. Instead of the gradual slopes of a volcano the high mountains now rise in abrupt cliffs, clad in trees to their summits, always green. Other areas are yellow, not with ash but with fern and cane. The valleys are full of fruit trees, which provided half our lunch on inland excursions. The emptiness of these once populated valleys —the stone foundations of the huts alone remaining to remind us of the dying out of a fine race—make a melancholy where all nature seems made for happiness. The merest remnant of the large and happy population which was here before the white man's diseases came is all that now persists, inhabiting the seaward ends of the valleys, and not even of them all. They were warlike and always hostile to their neighbours of the next valley, but that has not always been accounted a crime, at any rate, by poets and historians. Cannibals it is true, but even cannibalism had its religious meanings, and when the whole island—to them the whole world—was threatened by death from drought, desperate remedies were called for. No, the extinction of these kindly and once happy people is nothing but unrelieved and bitter tragedy, nothing but a reproach to the white man's greed and uncleanness.

The great problem of the Marquesas—one which has exercised many geologists—is the absence of coral reef from around their shores. They are quite near the equator, in practically the same sea as the hundreds of atolls of the Paumotus and the Society Islands with their great barrier reefs. Why then are they without reefs ? Ingenious geological theories have been suggested, but no one seems to have looked at the corals themselves. When this was done it was found that the number of species of coral able to exist around the Marquesas is remarkably few. The whole immense genus *Madrepora* (now, alas, renamed *Acrorpora* by the literal application of rules of nomenclature which ignores the whole spirit), the species of which are *the* characteristic forms of so many reefs, is altogether absent, and so are all the Astreans. *Porites* of two or three species is sometimes abundant, a few species of *Pocillopora*, a *Millepora* and a *Psammocora*, make up all the coral fauna. (A *Coenopsammia* is common from Panama to Tahiti, but this is never a reef builder.) How could one expect reefs with such a paucity ? There are some patches, one may even be called a reef, but only in sheltered bays. Elsewhere the rocks between and below tide levels are invariably covered with an organic coating, Zoanthid polyps, Millepora (usually as a mere encrustation), or the bivalve mollusc Anomia, but most abundantly and characteristically by a compound crust of Lithothamia (stony seaweed), Serpulid worm tubes and those of the gastropod *Vermetus*. This recalls the conditions in the Cape Verde Islands rather than any truly tropical shore formation. (*Vermetus* begins life as a typical crawling mollusc, but soon becomes fixed down to a rock, the shell then growing out as a tube like that of a worm. Even a skilled naturalist may take these shells for worm tubes, until one demonstrates the molluscan-toothed radula.) So, to postulate rises and falls of sea-level, extraordinary precipitous submarine slopes, or other geological phenomena, is uncalled-for until the sea itself has been investigated, and the restriction of the coral fauna explained.

An Improved Island.

Of the atolls of the Paumotus, only that of Napuka, far isolated to the north, was seen by me, as when the " St. George " reached Fakarava I was unable to land through illness. Napuka is one of the least accessible points in the Pacific, and the opportunity of seeing it so much the more valuable. The " sailing directions " describe the people as extremely primitive, unclothed and living upon the flesh of dogs and pandanus (" screw pine ") fruit. The South Sea Island dog is described by Captain Cook as not at all a bad meat, but no euphemism can cover the wretchedness of pandanus fruit. We found that the islets had been planted with coconuts, the people clothed

and the pig replacing the fatted dog. The inhabitants are not Paumotuans, but Marquesans, one of those cases in which a canoe blown out to sea did actually find and colonize an island hundreds of miles from its home.

Work Continuing.

The lagoon is described as full of coral rocks elevated above sea-level, but these are heaps of *Tridacna* shells lying on coral shoals, this large shellfish forming an essential part of the islanders' diet. What with the wind and the unmanageableness of the ill-shaped canoes we failed to see much of the lagoon, but saw that the shoals are formed largely of an abundant growth of *Madrepora*—one of the corals so conspicuously absent in the Marquesas. The island itself is largely made of branches of *Pocillopora*, thrown on to the reef by hurricanes. The origin of this coral debris is not the reef itself, but of the slope beyond its edge.

I parted with the " St George " in Tahiti, to begin a new chapter in my work aided by grants from the Royal Society of London and the Balfour Fund of the University of Cambridge. I am proud to be a lowly successor of those men of science whose work in these islands has given the name of the Royal Society to the group.

The Genesis and Execution of Ophthalmic Prescriptions.

By R. O. Raphell.

A pair of eyeglasses may seem a simple affair, but in practice a wonderful amount of applied scientific knowledge is required to supply the client with his oculist's prescription.

In a very stimulating criticism of modern social conditions, Mr. Anthony Ludovici has recently deplored the increasing and shameless use of spectacles among our degenerate population. It cannot be denied that the shell of the turtle is now often seen in the land, and that beauty's eyes too often languish behind artificial barriers. But the more frequent use of eyeglasses is not necessarily to be construed as meaning a general increase in the number of visual defects. The conditions of modern civilized life place a heavier burden upon the eyes and, by rendering us more critical of their behaviour, have probably tended to raise the accepted standard of normal visual activity.

The Eye as a Lens.

The central problem in the amelioration of vision is to ensure that a sharply-defined image is in all cases received upon the retina, that sensitive membrane which acts, so far as the optical system of the eye is concerned, as the sensitized plate in relation to the camera. The focal length of the refractive system of the eye is the resultant of the curves and refractive indices of its various components—namely, the anterior chamber, containing the aqueous humour and bounded in front by the cornea, the crystalline lens, which lodges immediately behind, the posterior surface of which coincides with the front surface of the vitreous humour. The latter is the thin transparent jelly-like fluid which distends the major portion of the eyeball. Emmetropia, or normal sight, in which the distance from the cornea to the retina is exactly equal to the focal length of the refractive system of the eye when adjusted for distant vision, is rare. As a rule, the eyeball is too long or too short, conditions which are known as myopia (short sight) and hypermetropia (long sight) respectively. The latter condition may be partly or completely overcome by encroaching upon the accommodative function of the crystalline lens which, in the normal eye, by an increase in its own curvature, would bring to a focus on the retina the light from objects too near to be clearly seen when the eye is adapted for objects at " infinity " (in practice, over six metres). In myopia, of course, there is no such immediate remedy available, so that short-sighted people are generally the first to discover their disability. In both cases, where the degree of error is not negligible, the only scientific remedy is the use of spherical ophthalmic lenses in order, as the case may be, to add to or subtract from the power of the refractive system of the eye.

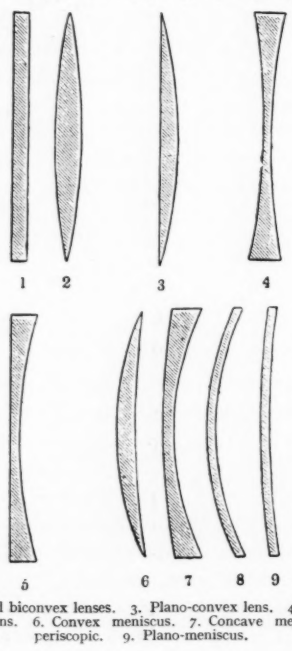
Correcting Errors.

Astigmatism may be explained as a discrepancy in refractive power between two meridians of the eye, so that they cannot bring parallel light to a focus in one point. The front of the eye is bounded by the sensitive transparent membrane known as the cornea which, in the perfect eye, would present a

spherical surface, but which in practice is found to have a radius of curvature in, say, the horizontal meridian of different length from that of the meridian at right angles to it. In other words, the front surface of such a cornea is toroidal in shape, and distributes its focal effects in a complicated series of elongated patches of light inimical to clear vision. The astigmatic cornea possesses, in fact, two focal distances, corresponding to the respective curvatures of its principal meridians. The initial remedy is therefore to nullify this inequality by the use of lenses which have their maximum refractive power in one meridian, and none at all at right angles to this. Such lenses, in contrast to the spherical lenses spoken of above, have cylindrical surfaces. If the discrepancy between the refractive powers of the two meridians of the astigmatic eye has been found, it is possible by means of the cylinder to reinforce the weak meridian and thus to neutralize the astigmatism. Finally, the effects of a spherical and of a cylindrical lens may be combined in a sphero-cylindrical or toric lens. In prescribing such lenses it is necessary to specify not only the power of both elements, but also the direction of the axis of the cylindrical component as so many degrees from the horizontal or vertical.

Optical Measurements.

Refractive power is expressed in dioptres, the dioptric value of a lens being given by the reciprocal of its focal length in metres. Thus a convex lens of four dioptres (written +4 D) brings parallel light to a focus at a point twenty-five centimetres behind it; a concave lens of two dioptres (written −2 D) causes parallel light to appear to diverge from a point fifty centimetres in front of it.



1 and 2. Plane and biconvex lenses. 3. Plano-convex lens. 4. Biconcave lens. 5. Plano-concave lens. 6. Convex meniscus. 7. Concave meniscus. 8. Plano-periscopic. 9. Plano-meniscus.

To ascertain precisely what combination of curves will correct the refractive error of a patient is a task calling for the technical skill of the ophthalmic surgeon or of the qualified optician. This is the process known as sight-testing, which may include both subjective and objective methods. The first kind consists in estimating the refractive error of the patient according to the degree of accuracy with which he can read the letters and see the lines of a test chart. By means of test lenses of known powers, the visual acuity is gradually and systematically increased until it reaches the standard or norm. The amount of the refractive error is then given by the combined dioptric power of the lenses in the trial frame. Objective methods consist in the use of instruments such as the retinoscope, the ophthalmoscope and the ophthalmometer, by which the refractive errors and the physiological condition of the eye may be ascertained by direct inspection.

New Kinds of Glass.

So much then for the form to be given to the lenses in execution of an ophthalmic prescription. Until recently, the choice of a medium was restricted to white crown glass of refractive index of 1.523. Largely owing, however, to the researches of the late Sir William Crookes, it is becoming widely recognized that considerable benefit may result from protecting the eyes from the ultra-violet radiations (and to some extent from the infra red) which are contained in solar and artificial light. It had formerly been considered necessary, in order to secure this protection, to prescribe for the patient lenses made of some tinted material, but the successful manufacture of Vitrex glass has now rendered this unnecessary, combining as it does the advantages of complete actinic protection with transparency throughout the whole range of the visible spectrum. Tinted lenses, which are unsightly and depressing, are never desirable where their use can be avoided, and there can be no doubt that the provision of a colourless anti-actinic ophthalmic medium such as Vitrex possesses widespread advantages in the sphere of optical science. We shall therefore assume from what follows that the lenses we are watching in the process of manufacture are being worked in this medium.

It is an important corollary to the correct execution of a prescription that the lenses shall be suspended firmly in a plane at a calculated angle to the axis of

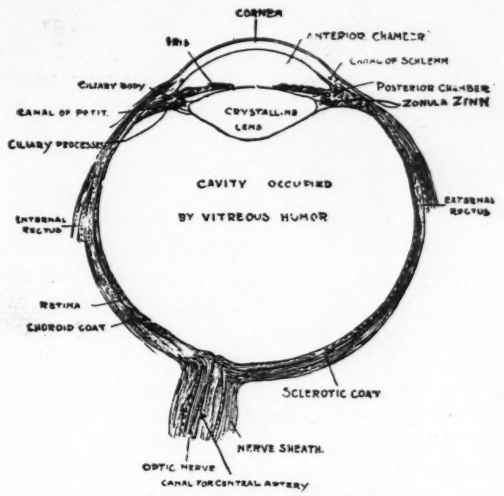
vision, and at a certain distance from the pole of the cornea. In addition, the lenses must be centralized with respect to the visual axis, and the axis of the cylinder, where such an element is present, must at all times set permanently in the required meridian. The task of frame measuring and fitting is therefore in itself a highly specialized one. The translation of all these measurements, ophthalmic and cosmetic, into terms of metal and glass—that is, the actual manufacture of the lenses and frames completely assembled and ready for wear—can rarely be undertaken by the optician himself. It is essentially the task for a factory, presupposing as it does the presence of considerable quantities of plant, equipment and material.

Standardization Needed.

Various registration schemes are now afoot in this country for co-ordinating the activities of ophthalmic opticians and granting them diplomas for sight-testing; and, as their attention is centred more and more on the therapeutic side, the actual execution of the prescriptions, a function which was always to some extent divided, will tend more and more to rest with the central prescription factory.

Ophthalmic prescription manufacturing is a branch of industry to which the principle of the division of labour—which is fundamental to all modern enterprise—has an application no less rigorous and extensive than to undertakings of a simpler and more completely mechanical kind. Specialization, the assignment to certain individuals of detailed and semi-mechanical tasks of limited scope, the subdivision of processes, the increasing use of machinery and the adoption of time-saving tabulated methods—all these features, which are characteristic of large-scale manufacturing, it puts necessarily and completely into operation.

Yet it has often been stated as a general principle of economics that the detailed specialization, the needs for checks and records of the big firm, involve routine which kills initiative and adaptability. To anyone acquainted with the optical industry it will be apparent that we are here confronted with a very striking exception. Ophthalmic prescription work may be said to base its very claim to existence, exclusively and precisely, upon being able to adapt its products to the minutest variations in type or dimension required by the consumer. Throughout the whole range of modern manufacturing undertakings, it would probably be impossible to find any category of service in which the detail involved and the delicacy of the materials employed are so great, the variety of possible combinations so boundless, or the standard of accuracy so exacting.



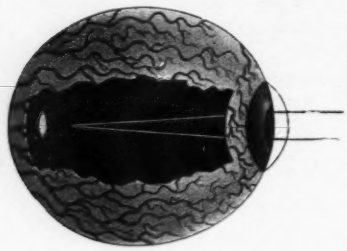
HORIZONTAL SECTION THROUGH THE RIGHT EYEBALL.

Apart from the mass of detail inseparable from the handling of orders on a large scale, it will be borne in mind that refraction work above all is essentially individual; in the application of its general principles there is room for a very wide variation of technique. The habitual or arbitrary preferences of individual customers must on each occasion be studied and translated into practice, due allowance being made for the unfortunate ambiguity to which optical terms are prone.

Even at this comparatively advanced stage of optical science and manufacture, there is still lacking that uniform and standardized terminology which so greatly facilitates the interpretation of instructions in certain branches of industry. Interpretation largely enters into the putting in hand of the innumerable prescriptions which reach the factory by every post from ophthalmic opticians in every quarter of the globe. Once classified, the original orders, analysed, dissected and rearranged, are transferred to internal works sheets containing any special instructions which may be considered necessary.

The Important Frame.

The "job" goes first to the frame department where the mounting corresponding most nearly in measurements to those specified in the prescription is selected and verified, but will seldom be found to conform precisely to requirements. It will pass therefore into the hands of workers specially skilled in the task of manipulation. Here the visitor pauses for a moment to examine the variety of rules, pliers, tools, and measuring apparatus required in the rapid alteration of prescription frames. In order to satisfy



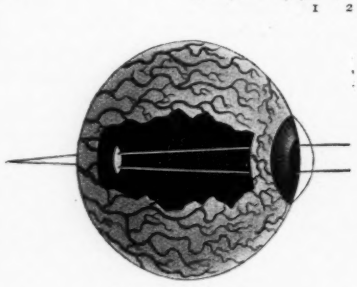
MYOPIA.

unusual indications, it is often necessary to make substantial alterations to the frames. Here more elaborate equipment is requisite, soldering apparatus, presses, large vices, wire-drawing machines, polishing buffs, lathes, etc. The visitor is rightly impressed by the fact that these exacting and minute operations, performed as a sort of elaborate appendix to manufacture upon an originally machine-made frame, entail an expense out of all proportion to its original value. This kind of drawback is inseparable from detailed manufacture, and tends greatly to swell the cost of production.

The Lenses.

The purely optical part of the job begins in the lens department with the selection of the requisite glass blank from which the lens is to be worked. An interesting commentary on the progress of ophthalmic prescription work in modern times is provided by the vast array of lenses with which the eye is here confronted. On the one side there stretch nearly a quarter of a million unedged, surfaced, spherocylinders in order to provide a stock sufficiently varied to ensure the rapid execution of unusual combinations. On the other side are the shelves which contain spherical lenses of various grades; complete stocks of bifocal lenses in half a dozen different varieties; raw glass blanks of every thickness and curvature; segments from which to make the reading portions of bifocal lenses; and tinted lenses.

The suitability of a glass blank for the working of any particular lens is indicated by its thickness and rough curvature, because the "sight" or refractive power of a lens varies with the nature and depth of its surface curves and with the refractive index of the glass of which it is composed. Surfaces are either spherical, convex, or concave; or cylindrical, convex, or concave; or toroidal, convex, or concave. A toroidal surface differs from a spherical surface as the shape of the surface of a motor-car tyre differs from that of a (Soccer) football. The inequality of the curves of the two principal meridians of a toric lens causes it to behave with respect to light as a combination of two cylindrical lenses of unequal powers placed with axes of their curves at right angles to one another. In such lenses, the focal powers of the two principal meridians must be considered separately; in spherical lenses, which refract equally in all meridians, there is, of course, only one focal power. In all cases a convex curve in one meridian causes objects seen through the lens to appear magnified in that meridian, whereas a concave curve has a diminishing effect. These are spoken of as plus and minus curves respectively. In the terms that have been employed, it can be seen that an ordinary magnifying glass, which enlarges and does not distort objects seen through it, is merely a plus sphere of larger diameter than that required for an ophthalmic lens. Finally, the values of the focal length, the refractive index and the radii of curvature of the two surfaces of the lens, are connected in the expression $\frac{1}{F}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$.

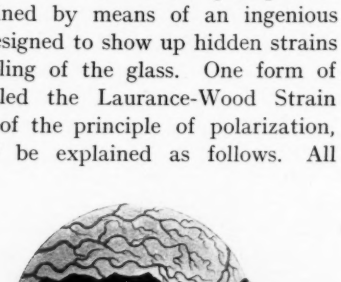


HYPERMETROPIA.

It will now be obvious that the stronger the lens—viz., the shorter its focus or foci—the deeper will be the curves of its surfaces. A certain care is therefore needed in the selection of the raw glass blank from which the lens is to be worked; for a lens with deep curves, a thicker blank will be required than for a lens with shallow curves. Toric lenses are shell-shaped in order to conform more nearly to the shape of the human cornea; the raw glass blanks from which such lenses are worked are therefore moulded roughly to the final shape.

Polarized Light Test.

Before a blank is passed to the surfacing shop to be worked, it is examined by means of an ingenious piece of apparatus designed to show up hidden strains due to faulty annealing of the glass. One form of such apparatus, called the Laurance-Wood Strain Viewer, makes use of the principle of polarization, which may roughly be explained as follows. All light is propagated by means of transverse vibrations in the ether, and an ether particle on the path of the beam is oscillating rapidly in every meridian. It is possible by the employment of



EMMETROPIA.

suitable optical means to quell the activity of the particles in one set of meridians; the light is then said to be partially polarized. If a second similar arrangement is placed in the path of the partially polarized beam at right angles to the previous plane of polarization, the light will be completely quenched, and an observer looking into the apparatus through the eyepiece will see merely a black field. A strain in glass possesses the property of de-polarizing a partially polarized beam and, in consequence, a glass blank, containing a strain, inserted between the two components of the polariscope, becomes immediately visible by means of the de-polarized light which it causes the instrument to transmit. The same instrument is used for the purpose of detecting strains in finished lenses when fitted in their frames or mounts, for stresses and strains are set up in the glass by the mechanical parts (the metal screws and straps) by means of which the lens is suspended.

In conclusion a word may be said concerning bifocal lenses which, as the word indicates, are lenses possessing two distinct focal systems; a bifocal lens, in short, is two lenses in one. On the surface of a lens of ordinary size is cemented or fused by a special process another thin glass segment of much smaller diameter.

MARKING AXES AND CENTRING LENSES.

Double Function Lenses.

The power of this smaller lens added to that of the main lens makes up the power of the reading portion, which is always at the bottom of the combination when mounted in the frame; the remaining portion of the lens is used for distant vision. Such two-vision lenses are of use to patients of advancing years who need stronger glasses for near than for distant vision. The accommodative power of the crystalline lens of the eye steadily decreases from the age of ten onwards, but in the normal eye the consequent loss in the power of adjustment for near objects does not become manifest until the age of forty-seven is reached. A normal subject would then require eyeglasses for near work, and a hypermetropic or long-sighted subject, who already requires convex lenses for distant vision, will need another pair of spectacles containing still stronger lenses for reading and near work. The use of bifocal lenses relieves the patient of the necessity for changing his spectacles and, since in the most successful of the modern fused bifocals the edge of the segment is almost invisible, their popularity is greatly on the increase.

Polishing and Testing.

Lens surfaces are ground to the correct curves by means of emery in progressively finer grades and the use of special tools on vertical lathes. Polishing on automatic spindles completes the process, the surfaces being all the time repeatedly examined under special lamps until the minutest pits and excrescences have finally disappeared.

The cutting of the lenses to the approximate size and shape required, the centring and marking of axes, the automatic grinding of perfect flat or bevel edges, the drilling and fitting, truing, finishing and inspecting of the finished job are all steps in an undertaking from which the risk of breakage is never absent, and in which the highest degree of technical proficiency must be maintained.

In an article of this kind a great deal must of necessity be left to the imagination. To some people so prosaic an affair as the purchase of a pair of gloves means an adventure into Arctic Seas, a pilgrimage across the trackless snow after the reindeer herds, the excitement of the chase, strange voyages in cargo vessels, and glimpses of great bales of hides on the quays of foreign ports. And by the same token, a spectacle case becomes the Pandora box which in the darkness of a myopic world sets free the gift of vision.

Books Received.

Is Evolution True? Report of Debate between GEORGE McCREEDY PRICE, M.A., and JOSEPH McCABE. (Watts & Co. 1s. net).

An Introduction to Physical Science. By IVOR B. HART. (Oxford University Press. 4s. net).

Prometheus, or Biology and the Advancement of Man. By H. S. JENNINGS. (Kegan Paul. 2s. 6d.).

Hephaestus, or the Soul of the Machine. By E. E. FOURNIER D'ALBE. (Kegan Paul. 2s. 6d. net).

Bulldogs and all about Them. By F. BARRETT FOWLER. (Jarrolds. 8s. 6d.).

Astronomical Physics. By F. J. M. STRATTON, D.S.O., M.A., F.R.A.S., F.Inst.P. (Methuen & Co. Ltd. 12s. 6d. net).

X-rays. By MAURICE DE BROGLIE. Translated by J. R. CLARKE, M.Sc., F.Inst.P. (Methuen & Co. Ltd. 12s. 6d. net).

The Principles of Sound Signalling. By MORRIS D. HART, M.Sc., D.I.C., A.M.I.E.E., and W. WHATELEY SMITH, M.A., M.Sc. (Constable & Co. Ltd. 12s. 6d.).

The Dawn of European Civilization. By V. GORDON CHILDE, B.Litt. (Oxon.). (Kegan Paul. 16s. net).

The Lost Oases. By A. M. HASSANEIN BEY, F.R.G.S. Introduction by SIR RENNELL RODD. (Thornton Butterworth Ltd. 21s. net).

The A.B.C. of Relativity. By BERTRAND RUSSELL, F.R.S. (Kegan Paul. 4s. 6d. net).

The New Matriculation Geometry. By A. G. CRACKNELL, M.A., B.Sc., F.C.P., and G. J. PERROTT, M.A. (University Tutorial Press. 4s. 6d.).

The Enrichment of Coal Gas by the Injection of Oil into the Retorts during Carbonization. Fuel Research Board. Paper No. 14. (H.M. Stationery Office. 1s. 9d. net).

Monthly Circular of Recent Selected Publications. No. 80. September, 1925. (H.M. Stationery Office).

The National Physical Laboratory Collected Researches. Vol. XVIII. 1924. (H.M. Stationery Office. 17s. 6d. net).

Science Progress. No. 78. Vol. XX. October, 1925. (John Murray. 7s. 6d. net).

Wireless Time Signals for the Use of Surveyors. By ARTHUR R. HINKS, C.B.E., M.A., F.R.S. (Royal Geographical Society. 1s. 6d.).

Electrical Educator. Part I. Edited by J. A. FLEMING, M.A., D.Sc., F.R.S. (Sir Isaac Pitman & Sons Ltd. 1s. 3d. net).

Elementary Inorganic Chemistry. By F. W. HODGES, B.Sc., F.C.S. (Longmans, Green & Co. 3s. 6d.).

Life: An Introduction to the Study of Biology. By SIR ARTHUR E. SHIPLEY, G.B.E., F.R.S. Second Edition. (Cambridge University Press. 6s. net).

Volumetric Analysis. By A. J. BERRY, M.A. Third Edition. (Cambridge University Press. 9s. net).

Bulletin of the Imperial Institute. Vol. XXIII. No. 3. 1925. (John Murray. 3s. 6d. net).

The Alkali Industry. By J. R. PARTINGTON, D.Sc., M.B.E. Second Edition. (Bailliere, Tindall & Cox. 12s. 6d. net).

Thrasymachus: The Future of Morals. By C. E. M. JOAD. (Kegan Paul. 2s. 6d. net).

Timotheus: The Future of the Theatre. By BONAMY DOBREE. (Kegan Paul. 2s. 6d. net).

Practical Methods in Microscopy. By C. H. CLARK, A.M., D.Sc. Fifth Edition, revised and enlarged. (George G. Harrap & Co. Ltd. 10s. 6d. net).

Tables and Charts for the use of Engineers and others giving Values of X_n. By A. D. BROWNE, M.A., Assoc.M.Inst.C.E. (W. Heffer & Sons Ltd. 1s. 6d. net).

Spitsbergen Papers. Vol. I. (Oxford University Press. 30s. net).

By Airplane towards the North Pole. By WALTER MITTELHOLZER and others. (George Allen & Unwin Ltd. 10s. 6d. net).

Ancient Egypt. 1925. September. Part III. (Macmillan & Co. Quarterly, 2s.).

Readable School Electricity. By VIVIAN T. SAUNDERS, M.A. (G. Bell & Sons Ltd. 2s. 6d.).

Social Psychology. By ROBERT H. THOULESS, Ph.D., M.A. (University Tutorial Press. 5s. 6d.).

Textbook of Palaeontology. By KARL A. VON ZITTEL. Vol. III: "Mammalia." Revised by SIR ARTHUR SMITH WOODWARD, F.R.S. (Macmillan & Co. Ltd. 25s. net).

Exercises in Practical Physics. By SIR A. SCHUSTER and C. H. LEES. Fifth Edition, revised. (Cambridge University Press. 12s. 6d. net).

THE PHOTOMICROGRAPHIC SOCIETY.

Session 1925-1926.

November 6. "The Agfa Colour Plate." Demonstration.

November 20. Members' Evening.

December 4. "The Role of Photomicrography in the History of Plate Making." T. Thorne Baker, F.Inst.P., F.R.P.S.

December 18. Members' Evening.

THE RONTGEN SOCIETY.

OFFICERS and Members of Council for the Session, 1925-1926:—

President: F. W. Aston, M.A., D.Sc., F.R.S.; *Vice-Presidents:* Robert Knox, M.D., M.I.E.E., N.S. Finzi, M.B., Prof. A. W. Porter, D.Sc., F.R.S.; *Hon. Treasurer:* Geoffrey Pearce; *Hon. Editor:* G. W. C. Kaye, O.B.E., M.A., D.Sc.; *Hon. Secretaries:* E. A. Owen, M.A., D.Sc., Russell J. Reynolds, M.B., B.S.; *Council:* G. B. Batten, M.D., H. A. Colwell, M.B., L.R.C.P., M.R.C.S., D.P.H., Prof. J. A. Crowther, M.A., D.Sc., E. P. Cumberbatch, M.A., M.B., M.R.C.P., A. K. Glover, J. E. A. Lynham, B.A., M.D., M.R.C.P., J. M. Woodburn Morrison, M.D., G. H. Orton, M.A., M.D., C. E. S. Phillips, O.B.E., Prof. S. Russ, D.Sc., W. E. Schall, B.Sc., G. Shearer, M.A., D.Sc.

HIGH VELOCITY PHOTOGRAPHY OF BULLETS.

(*Continued from page 421*)

to the powder particles which have passed the bullet is an unexpected revelation.

The new device may be expected to furnish a good deal of fresh knowledge concerning both sound-wave phenomena and also gas action at the muzzle of small arms. This function is important as it is used to operate some types of machine gun. An interesting feature of the new method is that it is also applicable for taking photographs of tracer bullets in spite of the light stream generated by the incendiary compound with which they are loaded. So far the use of the apparatus appears to be confined to fire-arm problems, but further applications to other needs for high-velocity photography may be found.

Queer Fish of the Sea River.

By Charles W. Domville-Fife.

Author of "Among Wild Tribes of the Amazon."

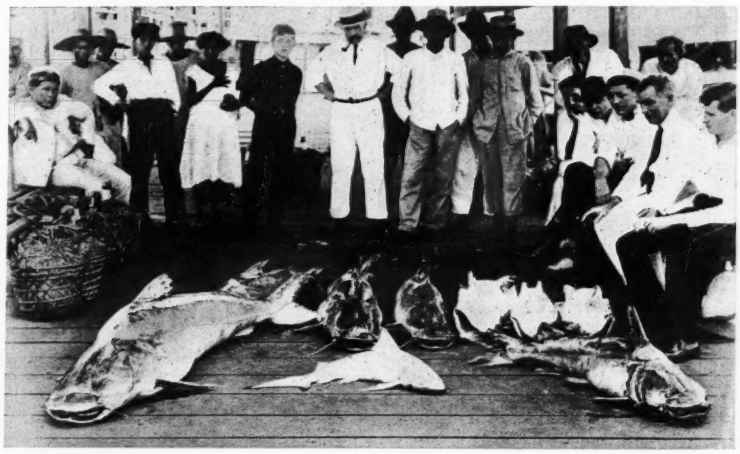
The natural history of South America is still very little known. The great rivers hold peculiar species new to science, and the field for zoological work is almost untouched.

In one small lake of the great Amazonian river system no fewer than 1,200 different species of fish have already been identified. This, however, represents only a few of the varieties which, undoubtedly, have their habitat in the 30,000 miles of navigable waterways which form the Sea River of the South American Aborigines.

Of the known species the most curious, and at the same time the most repugnant is, undoubtedly, the *piranha*, or

A Collector.

cannibal fish. A representative of the London Zoo has recently been in Amazonia endeavouring to obtain living specimens of this and other queer fish of these mysterious rivers and lagoons.



SOME OF THE EXTRAORDINARY FISH CAUGHT FROM A STEAMER ON THE AMAZON.

The piranha inhabits only the black waters of the Amazon system. Here it should be mentioned that although the parent stream, which rises in the Peruvian Andes and flows across the continent, through the great and unexplored forests of Equatorial Brazil, to the South Atlantic, is of a distinct yellowish-brown colour, the waters of many of its tributaries are of different hues. For instance, the Tapajós is of a bottle-green colour, the Rio Branco is a sickly white, and the Rio Negro is a black river.

Although these waters of varying colour join the main stream, they do not mix with it until many miles from the junction. A black stream will often be seen flowing side by side with the yellow Amazon; patches and whirlpools of green water mottle the surface of the amber flood; acres of milk-white, with clearly defined borders, occur in black rivers, and the varieties of water-colouring are almost endless.

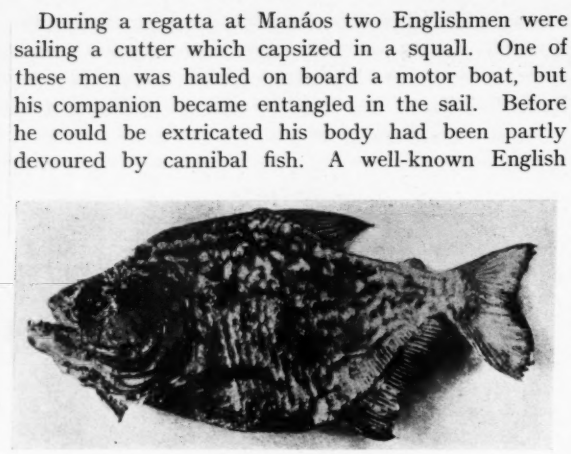
To return to the subject of this article; the piranha, which is not much larger than the common shad, is a ferocious little fish which seems to scent blood from afar. It hunts in shoals of many thousands and has been most appropriately named the river wolf. In appearance it is of a bluish-grey colour with fierce, blood-shot eyes. The jaw is heavily undershot, and the teeth are conspicuously large and very sharp. Whether singly or in shoals—as is more usual—it does not hesitate to attack both animals and men.

Notwithstanding the small size of the piranha, its appetite for flesh seems almost insatiable. In the isolated town of Manáos, which stands on the banks of the Rio Negro, about nine miles above the junction of that river with the Amazon, and just over 1,040 miles from the sea, there are to be found many natives who have had one or two fingers or toes bitten off by these cannibal fish.

Cattle Destroyed.

Some few years ago, in the Rio Negro, cattle were being landed from a river steamer moored about twenty or thirty yards from the bank. It was not then considered possible that these small fish would attack cattle during such a short swim. Scenting blood, however, they collected in thousands from the surrounding depths, and tore the animals literally to pieces before they could reach the river bank.

During a regatta at Manáos two Englishmen were sailing a cutter which capsized in a squall. One of these men was hauled on board a motor boat, but his companion became entangled in the sail. Before he could be extricated his body had been partly devoured by cannibal fish. A well-known English



THE PIRANHA OR CANNIBAL FISH.

naturalist who accompanied the late ex-President Roosevelt on his journey of exploration into Amazonia, was once attacked by these fish while bathing, but escaped with the loss of a piece of flesh out of his leg. During the same journey Colonel Rondon, of the Brazilian Indian Service, lost a toe, and the author has seen native children badly bitten while bathing on the edge of the black water.

The cannibal fish is, however, by no means the only queer denizen of the Amazon rivers, which literally teem with strange species. There is the *piraracú* which ranges from seven to fifteen feet in length, and weighs anything from 150 to 600 pounds. This huge fish, which is known on the Brazilian Amazon as the *piraracú* and to the natives of Peru as the *paiche*, is, undoubtedly, the largest fresh-water fish so far discovered.

Fish Spearing.

The piraracú is of a blackish-brown colour, and is covered with large hard scales, about three inches in circumference and outlined in red. Its head is long and snout-like, but looks somewhat incongruous because of its small depth from crown to base. The eyes are red and bulging; the tongue is hard and bony with a rasp-like surface, and when dried it is used as a file by the Indians and pile-dwellers of Amazonia.

This huge fish is hunted very largely for food, although, to the European taste, the flesh has a distinctly unpleasant flavour. The natives cut the meat into long thin strips which they salt and dry in the sun. The piraracú is hunted with an eighteen-foot lance, having a barbed head which becomes detached from the shaft on piercing this immense fish. Attached to the spear-head is a short but very strong line, on which the piraracú, which fights hard for its life, is played until it is exhausted and can easily be given the coup-de-grace with a short spear.

The Electric Eels.

Another unpleasant creature of the yellow depths is the electric eel (*gymnatics electricus*), which kills its food by discharging a powerful electric shock which is capable of stunning many of the larger fish and of paralysing the arms and legs of swimmers. Even more dangerous, however, is a curious type of sting-ray which resembles a huge skate and is of a sickly-white colour. It has a peculiarly repulsive facial arrangement, and near the end of a powerful tail is its weapon ——made, apparently, of black vulcanite, about eight inches long. The lightest touch on the body of the ray causes this dreadful weapon to be darted forward. The sting which results is not only painful to human beings, but the injured limb or part sometimes takes several weeks to fully recover from the curious effect.

There is a common species of fish, which is found in a variety of shades from grey to blue, called by the natives *acari*. It is shaped something like the gurnet, and is about twelve inches in length. Its most uncommon feature is the mouth, which is under-

PIRARACÚ FISHERMEN.

neath, and is lined with a circular membrane. By lying on its back in shallow water small fish are caught by these curious membranes. The acari burrows a hole in the river bank and lives in this miniature submarine cave. It is armoured all over with hard scales, or plates.

The *canderu*, although small, is a most weird creature. It is dart-like in both shape and method of attack. By a short but quick charge through the water it

buries its sharp head in the body of its enemy, much in the same way as a miniature sword-fish, being only six or eight inches in length.

Among the hundreds of different varieties it is possible to give here only a few of those with known peculiarities. Very little exploration work has been carried out in the rivers and lagoons, and it is no uncommon occurrence to pull up on the hook a specimen which cannot be placed in any accepted category, and whose habits and peculiarities are unknown. It is a wise precaution to handle all such fish very carefully, for more than one variety is possessed of a poisonous spike or lance.

The *pescada* is a medium-sized fish which contains two pearl-like substances in its head. The *tucanaré*, which affords wonderful sport with rod and line, is caught by baiting a spinner with red rag; and there are at least two varieties of large and very voracious scaleless fish.

Mermaid or Cow-fish.

Among the family of cetaceans which inhabit these waters, mention must be made of the *peixe-boi*, or cow-fish, which is seal-like in appearance, with a grey back and pink and grey marbled body. Its

A NATIVE FAMILY WITH THEIR FISHING DUG-OUT.

method of suckling its young while holding them in its flippers makes it reasonable to suppose that this animal was the Amazonian mermaid of the ancient mariners. It is extremely difficult to catch because of its wonderfully acute sense of hearing.

The *boto*, of which there are several species, is an ugly creature of either a white or red colour. Keeping in the deep channels or lakes they swim in pairs. The red species is the most fierce, but both are carnivorous. It is stated by the natives that when they come up to breathe a most offensive smell is thrown off. Among other queer creatures there is the ordinary river turtle which is, perhaps, the most inoffensive and preyed-upon creature in this wild land of river, swamp and forest. Then comes the *mata-mata*, or snake-head, mud turtle, about three feet in length, which feeds almost exclusively on small water snakes and reptiles; the gigantic anaconda, often thirty feet in length, which with the aid of its coils breaks all the bones of its prey before devouring the body *en masse*; the *iguanas* and finally the alligators, which vary from nine to twenty feet in length.

Although Liverpool liners now carry tourists in complete safety and comfort for a thousand miles up the main-stream of the beautiful Amazon, taking them by river-paths through the thick jungle to the *Ultima Thule* of civilization, there exists nowhere in the world to-day such a virgin field for geographical discovery and scientific research as in the two million square miles of unexplored Amazonia.

THE EGYPT EXPLORATION SOCIETY.

THE Committee of the Egypt Exploration Society have arranged five lectures for the coming session, as under. They will be given at 8.30 p.m. in the Lecture Room of the Royal Society, Burlington House (by kind permission of the Council).

November 17th, 1925. "Applied Science in Ancient Egypt." Colonel H. G. Lyons, F.R.S. (Postponed from last session).

January, 1926. "Alexandria and Constantinople: The Struggle between Emperor and Patriarch." Norman H. Baynes.

February, 1926. "The Labyrinth and Egypt." Dr. V. Burch.

March, 1926. "Scarabs." H. R. Hall, D.Litt.

THE CHLOROPHYLL OF MARINE ALGAE.

ARE the sea plants of any particular locality as deeply coloured as those of the land? Those of the Black Sea are not. They contain ·008-·069 per cent of chlorophyll (the green colouring matter of plants) while the land plants from the same district contain 0·46 per cent. Whether this difference can be accounted for by the opacity of the water they live in is undecided, but it is thought that it cannot since some of the deep living algae contained a greater percentage than those inhabiting the surface. We have now to discover what is the real cause of the difference.

Ostracods.

By Sir Arthur E. Shipley, G.B.E., F.R.S.

These minute crustacea act as the scavengers of our seas and fresh waters. Some forms have been found as fossils as far back as in Cambrian rocks.

THERE is a group of minute crustacea seldom exceeding a millimetre or so in length known as Ostracods, and when ostracods occur in large numbers they act as the scavengers of the sea and fresh water, for they eat up dead and decaying organisms, and in this way prevent the poisons of decay spreading through the aqueous medium. Of all crustacea they have the smallest number of appendages, and their body is usually unsegmented or only faintly segmented. A common species of ostracod in the fresh water of our islands is *Cypris*. It has a body flattened from side to side enclosed in two lateral shells which recall those of a mollusc. In fact, the word ostracod means "shell-like." In some respects the animal resembles *Daphnia*, but the head never protrudes beyond the valves of the carapace or shell, and there is usually a special notch through which both pair of antennae can be protruded. The shell is opened like that of a fresh-water mussel by an elastic ligament on the upper or dorsal surface, and it is closed by the contraction of a muscle which runs across the body from shell to shell. The position of the attachment of the muscle to the shell is often of systematic import. The surface of the shell may be smooth or sculptured and it may be beset by little bristles. In one group each valve of the shell is well supplied with glands. The edges of the shell are free both in front and behind and all along the under surface.

Swimming Mechanisms.

Some forms swim freely by the lashing of their first antennae, which may be provided with olfactory hairs. The second pair of antennae also take a prominent —perhaps the most prominent—part, in swimming. These appendages resemble legs and end in strongly hooked bristles by means of which the animal can attach itself to surrounding objects. The third pair of appendages are the mandibles, usually with broad-toothed biting edges. In other forms, however, the mandibles have the form of legs rather than jaws; and in a few rare cases they take the form of styles which are enclosed in a sucking proboscis formed by the upper and lower lips. The mandible often has a palp or sensory process attached to it. The first maxillae may be jaw-like or leg-like. The second in one large family, the *Cypridinidae*, carries a very large respiratory plate. Behind that the sixth pair of appendages may be either jaw-like or leg-like or absent, whilst the seventh pair of appendages are either leg-like or absent. In those species in which there is an eighth pair of appendages the latter frequently take the form of the male organ for introducing the spermatozoa into the female. The remainder of the body is rudimentary and ends in two processes forming a caudal fork.

Microscopic Anatomy.

Another point in which ostracods differ from the cladocera, which includes *Daphnia*, is the fact that some of the internal organs of the body extend into the space between the double flaps which form the right and left shells, the ovary, the testes and branches of the liver or digestive gland are prolonged into the valves of the carapace. Ostracods as a rule progress by swimming, and although the second antennae take the chief part in this form of locomotion both antennae are used, and this again is different from that which occurs in *Daphnia* and its allies.

The nervous system is typically crustacean, consisting of a bilobed ganglion above the gullet, a large ganglion below the gullet which supplies nerves to the mandibles and first maxillae, and a short chain of nerve-centres or ganglia running along the under side of the body. A few ostracods are blind, but as a rule the single median eye of the larval or nauplius-stage is retained, and in the *Cypridinidae* there is in addition a compound eye on each side, made up of from four to fifty or so separate elements. There are in addition olfactory hairs.

The mouth leads into a narrow gullet which opens into a dilated crop. In one genus there is an interesting foreshadowing of the gastric mill of the crayfish or lobster. This takes the form of hardenings or thickenings which are used in masticating the food. The crop opens into the stomach and the stomach receives the secretion of the liver, part of which, as we have said above, lies within the two walls of the right and left shells. There is a short intestine which opens either above or below and in front of the caudal fork.

Some species have a heart, but other species are heart-

less. When present it lies on the upper surface near to where the shell fuses with the body. Apparently respiration is carried on by the inner surface of the shell as well as over the whole surface of the body. A regular circulation of water within the shell is kept up by means of the rowing movements of certain of the limbs. There are no outer gills as there are in the higher crustacea.

Gland Problems.

There has been a considerable confusion about the excretory glands of the ostracods, and this confusion has recently been cleared up by the researches of Dr. Graham Cannan. Many years ago the great German zoologist, Claus, described a large gland lying between the lamella of each shell which he traced into the base of the second antennae, though he could detect no opening. This he called the "shell-gland." Another pair of glands he described opened on by a triangle of contractile fibriles occurring in the cells. This gland is at its maximum during the fourth larval stage, after which it loses its opening to the exterior and degenerates. On the other hand, the maxillary gland persists and it has an end-sac and a duct of four cells pierced by an intercellular duct. It also has a triangular arrangement of muscles forming a valve. The ducts are in all cases formed from the outermost layer of cells or the ectoderm, whereas the end-sac corresponds with the body-cavity sac of other arthropods. The function of the shell-glands mentioned above, whose external opening has not yet been discovered, is unknown.

The sexes differ externally. There are always males and females, and they present well-marked structural differences. The male usually possess on one or other pair of appendages appliances for holding the female, and there is a very large and complicated structure by which the spermatozoa are introduced into the

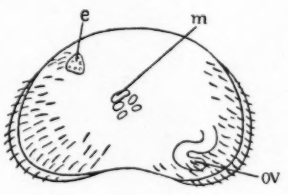


FIG. 1.
AN EXTERNAL VIEW OF *CYPRIS*.
(*e*) Median eye; (*m*) Adductor muscle; (*ov*) Ovary.
(*After Gerstaecker.*)

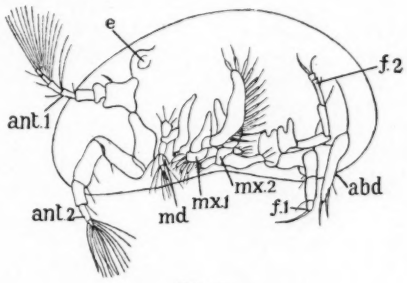


FIG. 2.
AN EXTERNAL VIEW OF *CYPRIS*.
With the appendages exposed by the removal of the left valve of the shell.
(*abd*) Abdomen; (*ant.*1, *ant.*2) Antennae; (*e*) Median eye; (*f.*1, *f*2.) Thoracic feet; (*md*) Mandible (*mx.*1, *mx.*2) Maxillae.
(*After Gerstaecker.*)

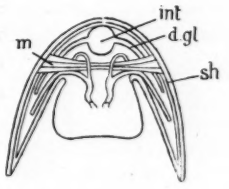


FIG. 3.
TRANSVERSE SECTION OF *CYPRIS*.
(*d.gl*) Digestive gland; (*int*) Intestine; (*m*) Adductor muscle; (*sh*) Shell.
(*After Gerstaecker.*)

the basal joint of the second maxilla. These did not penetrate into the shell. As a rule in crustacea the excretory glands, which perform somewhat the same functions as our kidneys, are confined to those segments which bear the second antennae and the second pair of maxillae. But usually one pair disappears—for instance, in the crayfish the antennal gland or the so-called green-gland alone persists throughout life. In the smaller crustacea such as *Daphnia* and the ostracods, with which we are now dealing, the maxillary gland persists and the antennal one disappears. Cannan has pointed out that the so-called shell-gland of Claus is not really a true segmental excretory organ, and its function is unknown. The antennal gland consists according to him of an end-sac with a duct piercing through the bodies of three cells only, and then opening to the exterior. The entrance of the duct into the end-sac is guarded

body of the female. The testes are generally simple globular bodies which open by a common duct just in front of the hinder end of the body. In the *Cypridae* the testes present four rounded lobes and the two ducts are connected by a canal which may form a coil of great length. The most remarkable thing about the whole group is the enormous size of the spermatozoa which fertilize the eggs of the female. In *Pontocypris monstrosa* they may be three to seven millimetres in length, that is to say, eight to ten times the length of the whole body of the animal. In the female there are two ovaries, and oviducts, the former penetrate between the lamellae of the shell. There are two receptacula seminis where the spermatozoa are stored up, and these open at the base of the abdomen. The shape of the shell often allows one to discriminate between the sexes, and a male is always endowed with more sensory organs than the female.

Book Reviews.

General Zoology. By H. L. WIEMAN, Professor of Zoology, University of Cincinnatti. (McGraw Hill Publishing Co. 15*s.* net).

Textbooks of zoology are necessarily not the most flexible of forms. The author has continually to bear in mind the restrictive influence of lectures and courses, and is controlled not only by the limits of progressive treatment of a wide-spreading subject, but by the artificial limits of a "course."

Professor Wieman is to be congratulated on producing a far better arrangement than is usual; best of all he has broken away from the systematic approach from protozoa upwards and takes his students straight from the introductory chapters into interesting, clearly written lectures on the organs of digestion, respiration, circulation, etc. The illustrations are drawn from common laboratory animals, mostly vertebrates, and there is a good deal of illustration from the human body. This is extremely sensible, for it maintains interest and widens the scope of the book, making it useful as a preliminary textbook for medical and physiological students as well as zoologists.

This excellent feature of interesting examples, accompanied by good and plentiful illustrations rightly placed in their reading matter and not a page or two away, is followed throughout. The clarity of arrangement is matched by a concise lucidity of style and a praiseworthy use of English words in place of scientific jargon. The general outlook is comprehensive, and the chapter on the evidence for evolution necessary in a work of American provenance, is sound and not allowed to bob up irrelevantly in other chapters.

The author reproduces the familiar Drosophila diagrams in the chapter on heredity. Any other symbol, say, guinea pigs, would do as well, and it must be confessed that many people besides students find the fly diagrams peculiarly irritating. This point might entertain a psychologist, but might be remembered in a future edition.

The book can be cordially recommended not only as a class book, but for general use by the home reader.

K. M. H.

Scientific Paradoxes. By A. S. E. ACKERMANN, B.Sc. (Old Westminster Press. 5*s.* net).

The crossword puzzle may be the latest thing in time-wasting energies, but the scientific puzzle is far more entertaining. It gives rise to discussion. Mr. Ackermann here sets out a wide range of the old problems which are raised by the inquiring to distract the physics master from his work. The problems vary from simple fallacies dependent on the limits of interpretation of words to ingenious problems in engineering. For instance, "Does any part of a train move backwards when the train is going forward. And is any part stationary?" "If a piece of iron be thrown overboard from a ship in mid-Atlantic, does it sink to the bottom or does it stop at some depth where the pressure of water is sufficient to support it?" The book contains a fair proportion of mathematical puzzles, of which the most interesting are long-division sums with most of the figures represented by letters or dots. The book is sure of a welcome and will be found useful for trapping the well-informed.

Talks about Wireless. By SIR OLIVER LODGE. (Cassell. 5*s.* net).

Wireless has caused millions of people to study a limited amount of elementary electrical knowledge, but very little of it has been more than rule of thumb "practical" application. Sir Oliver Lodge has come to the rescue with a book which redeems wireless from being entirely a hobby, and connects it with the more serious study of physics. From time to time educational authorities have suggested that the fervour with which schoolboys embraced wireless was not altogether a trait to be commended. It bred an absorption in constructional detail, but it was doubted if the scientific element were not lost in the joys of the amateur mechanic. "How to make" was more enthralling than "Why it acts." Sir Oliver Lodge does certainly give a moderate amount of practical advice as well as some interesting formulæ, but in the main this entirely delightful book is a dissertation on physics as illustrated by wireless rather than wireless illustrated by physics. It can be cordially recommended not only to the younger generation but to all and everyone who owns or makes a wireless set. To read and understand the book (and it is clear and easy) should be the duty of everyone who has indulged his hobby and glossed it to his conscience that he was "being scientific." Not the least of its value is the continuous tribute to scientists and mathematicians who made wireless possible and laid the foundations for its commercial exploitation.

Experiments in Genetics. By CHARLES CHAMBERLAIN HURST, Ph.D., F.L.S. (Cambridge University Press. 50*s.* net).

In this volume the theory, and even more important, the practice of over thirty years work on genetics are presented in a series of collected papers. The papers reflect the wonderful progress made in the science of genetics during this century, and the volume will stand as a model of work and a quarry of material for generations yet to come. It is a substantial record of Mendelian work ranging from experiments with bloodstock to some delightful studies in flower breeding which are of vital interest to the scientific horticulturist.

Rabbits, orchids, wheat, poultry, roses, and all manner of material has been scientifically tried out under normal country estate rather than artificial laboratory lines. Burbage may be taken as a model estate where scientific interest is dominant and breeding is practised as a science as well as a hobby. The importance of the book to the serious student need not be stressed—it is the work of an accepted authority; but it is to be hoped that it will also attract the attention of many country gentlemen who, already interested in genetics, may be inspired to pursue their studies and record the results. The practical value of the study of genetics is only gradually becoming apparent to the layman, and this book makes a very wide record of results of past work available to him.

A Summary of Physical Chemistry. By PROFESSOR K. ARNDT. Translated by W. H. PATTERSON. (Methuen & Co. 3*s.* 6*d.* net).

This little book furnishes a useful supplementary link between the physical and chemical courses and will be useful to students preparing for their final examinations. It is condensed to the utmost but furnishes adequate examples. It will be welcomed by many students who are conscious of a weakness on the physical side of their knowledge of chemistry.

A Text-Book of General Botany. By RICHARD M. HOLMAN and WILFRED W. ROBBINS, of the University of California. (Chapman & Hall. 20*s.* net).

This book serves two ends, for it embodies a course of botany suitable both for the general student and the agricultural student. In its breadth of scope it presents the subject as usually treated in a generalized course of lectures and laboratory demonstration, but it breaks new ground by relating all examples where possible to practical agricultural or industrial applications.

The book is astonishingly well illustrated and the make-up is good. The illustrations and diagrams have not been casually dropped in so that the student has to turn back or forward for several pages, but are close to appropriate context. As is natural, many examples are drawn from specifically American plants. This necessarily involves a remoteness from European conditions which would make it somewhat out of place as a textbook in Great Britain, but it may prove useful for overseas universities where local conditions are nearer to American standards than our own.

The Riddle of the Earth. By "APPIAN WAY." (Chapman & Hall. 10*s.* 6*d.* net.)

This is one of those crazy books where the author gets up on his hind legs and sets out a perfectly preposterous theory contradictory to all accepted scientific fact.

Meteorites hitting the earth produce volcanoes is his argument. Eruptions are due to meteoric gases being, so to speak, sucked in by existing volcanoes. We do not believe that there is anything at all in the theory, but it is vastly ingenious reading. Anthropology, geology, seismology, and a wide range of science is pressed into service to support a violently controversial and damnably heretic point of view. It is the kind of book which leaves one wondering whether possibly (and quite against one's good sense) there is not something or other to be said for his argument. The most convincing, or possibly the least irrefutable point, is his theory that glacial drift is not glacial but meteoric bombardment. It requires the skilled knowledge of about ten specialists to get up and confute on their ground the wholesale indictment of accepted theories that Appian Way flings casually at the scientific world. The book is not quite mad enough to be dismissed without discussion, and parts of it are quite logical. It can be depended on to produce a good deal of snorting and pooh-poohing, but we should rather like to see it comprehensively answered rather than dismissed as not worth talking about.

Aerial Surveying by Rapid Methods. By BENNETT MELVILL JONES, A.F.C., M.A., and MAJOR J. C. GRIFFITHS, B.Sc. (Cambridge University Press. 16*s.* net).

During the war aerial surveying was used on the Western Front mainly for correcting existing maps, but in the East, where the campaigns were conducted in unsurveyed country, almost all topographical knowledge was gained from the air. The technique was rudimentary. The whole art developed as new improvements in machines and apparatus were evolved, but it was at best a makeshift and liable to an overfull margin of error.

To the late Major Griffiths we owe the work which has made this extremely valuable book possible. He saw the possibilities of aerial survey for the mapping of the vast unexplored unmapped areas of Australia, South America, and other unmapped lands. He saw at the same time that aerial mapping would have to be far more accurately systematized if it was to be of real engineering and topographical value.

Training and special instruction are the foundation. Aerial surveying must be dependent on reliable flying and solid routine work for its basis. This is the only structure on which dependable navigationally controlled flights can be established. The author suggests surveys on squares with a thirty- or fifty-mile side with a combination of vertical and oblique cameras which would enable a fair estimate of the content of the interior of the square to be roughly plotted. The book gives a most careful study of the whole process of map-making and apparatus. Everything is worked out from the point of view of the reduction of error, and the discussion of the methods of elimination is precise and clear. We have no hesitation in saying that this book is the most valuable work on this extremely difficult subject which has appeared in any country. It is the beginning of a new scientific system of topography.

Astronomical Physics. By F. J. M. STRATTON, D.S.O., M.A., F.R.A.S. (Methuen & Co. 12*s.* 6*d.* net).

The astro-physicist has to a large extent inherited the mantle of the old speculative astronomers. The development of the spectroscope and the photographic plate during the last half-century have provided him with instruments with which, to probe the secrets of the stellar universe. This book is essentially a student's book written for the use of workers, but it is not overburdened with mathematics, and is a remarkably interesting book even to those who are not astro-physicists but who have a general interest in science.

The amateur astronomer will find it a mine of interest, for it carries us into the field of modern research work. The science master will find in it material which will add interest to his lectures and show how present-day applications of the spectrometer are leading us to an understanding of the mysteries of variable stars and nebulae, and the connection between a star's mass and its luminosity. The chapter on Stellar Classification gives a useful survey of the conflicting systems used in the past and details of the Harvard Draper system internationally adopted in 1922. The book is well arranged, extremely comprehensive, and includes a most valuable and extensive series of tables. Its importance will be recognized by the professional worker, but it will also find a welcome among the far larger body of general readers who need a standard book on this subject.

The Evolution of Anatomy. By CHARLES SINGER, M.A., M.D., F.S.A. (Kegan Paul. 12*s.* 6*d.* net).

The slow stages through which medical men of the past reached to an understanding of the internal geography of the body seem to us moderns astonishing. It is difficult to realize that the average educated layman of to-day possesses greater anatomical or rather physiological knowledge than many of the great physicians of the past. For the explanation we must look rather to the psychology of past ages where trammels of a kind unknown to-day hampered research. Dissection was forbidden, the authority of Galen was unquestioned, and the whole realm of natural science was restricted by academic orthodoxy. Professor Singer has produced a most timely and excellent survey of the evolution up to the time of Harvey, and it is good to learn from the preface that the physiological movement beginning with Harvey will be treated in a future book. The author gives his reader a clear coherent picture of the great figures who advanced or in some cases retarded the progress of anatomical knowledge. Adequate references are given, but the book is not studded with useless if learned footnotes, and is a pleasure to read. A wealth of illustrations

from early books show the close contact between art and anatomical study, besides affording vivid images of the knowledge of their time.

It is a book which should have a wide appeal not only to the medical man interested in the history of his craft, but also to all who study the development of scientific knowledge as a whole.

The Growth of the Mind : An Introduction to Child-Psychology. By PROFESSOR K. NOFFKA. (Kegan Paul. 15*s.* net).

The development of the " Gestalt " theory to phases of early mental growth is attracting more general attention in this country. The book is important to all students of educational psychology, and is indeed useful as an introduction to the application of the Gestalt theory in principle. The chapters on motor and sensory learning are peculiarly well-arranged, and convey a clearer view of a child's mental processes than many recent books on the subject. An excellent bibliography is included. The book can be recommended to advanced students.

Everyday Physics. By H. E. HADLEY, B.Sc. (Macmillan. 6*s.* 6*d.* net).

This book may be compared with contemporary American schoolbooks of a similar standard, but while adopting their method of introducing up-to-date instances of commercial applications of physical laws, it lacks the typical American quality of driving the points into the student.

The few modern illustrations are overshadowed by the usual old-fashioned blocks of great men and obsolete electrical instruments.

X-rays. By MAURICE DE BROGLIE. Translated by J. R. CLARKE, M.Sc. (Methuen & Co. 12*s.* 6*d.* net).

The second edition of this book has been materially expanded and brought up to date to include more of the X-ray spectra determined since the production of the first edition in 1922. New apparatus is included to a very limited extent, and the bibliography is poor. The book will give the student a clear idea of the developments of X-ray spectrography, and is intended rather for the general student than the specialist.

The Principles of Sound Signalling. By MORRIS D. HART, M.Sc., and W. WHATELY SMITH, M.A., D.Sc. (Constable. 12*s.* 6*d.* net).

Sound was the one branch of physics concerning which relatively little was known when the war called all resources of applied physics into active use. Recently more attention has been paid to it, and the literature of acoustics is being extended. This book is mainly a study of the conditions and laws under which maximum effect can be produced with the minimum expenditure of power. It finds an application in syrens and foghorns.

Volumetric Analysis. By A. J. BERRY, M.A. (Cambridge. 9*s.* net).

This third edition of the well-known class-book has been brought up to date with modern analytical practice by the addition of a valuable chapter on the theory of indicators. The book furnishes an excellent bridge between the simple elementary textbook and the standard works of the practising chemist.

A Treatise of Electricity. By F. B. PIDDUCK. Second edition. (Cambridge University Press. 21*s.* net).

This admirable textbook of advanced electricity has now been brought up-to-date. The new edition embodies the advances of the last decade, including the application of Rontgen rays to crystal analysis and includes modern conceptions of the electrical theory of matter.

Piracy in the Ancient World. By HENRY A. ORMEROD, M.A. (University Press of Liverpool. 10*s.* 6*d.* net).

There is none of your Lovat Fraser decoration and the strutting infidelities of the eighteenth century about this book ; nothing of the glamour of the Carribees, buried moidores and our own rum-pickled pistol-blazing ruffians who made their weight felt in the New World. No ; one feels that these pirates of the Old World were a craven-hearted pack ot Levantine scum and that it is probably the inscrutable wisdom of Providence that decreed that in those days our British ancestors should stay in a placid state of barbarism, peddling lead and tin to Phoenicians and not dreaming of sea venturing.

As a whole this book strikes a singularly modern note. These pirates of the ancient world correspond closely with their descendants of to-day. True, the slave trade has decayed and a beautiful youth walking about ashore is in no danger of kidnapping. Just as well perhaps, for modern science would help the committee of aesthetes on the poop with high-powered prismatic glasses and a petrol-motor would supplement the fickle winds of the Peloponnesus.

This book is primarily archaeological, and there is more solid research and Greek words to it than fancy tales of piratical men. Fear of pirates was one of the main factors in Mediterranean civilization, and it is only by making allowance for this that we shall be able to understand the records we recover from the buried past. Professor Ormerod has written a most comprehensive study of the subject and a very good book.

Experimental Science : Physics. By S. E. BROWN. Section VI. Sound. (Cambridge University Press. 3*s.* 6*d.* net).

This little volume completes Part I of " Experimental Science." It is an excellent little manual for class or laboratory use, and does not assume that every school has a wealth of apparatus at command. The examples are interesting and well chosen, and it will appeal to teacher and pupil alike.

HUMBLE BEES: THEIR NESTS AND CUCKOOS

(*Continued from pnge* 419.)

Queen he has found alive—it is impossible to say continuing to lay eggs—several times in spite of the presence of the egg-laying Cuckoo Queen whose brood was being reared by the hortorum Workers. Interesting questions arise here and further observation may reveal why the hortorum Queen is spared; whether she is a milder bee, or more easily cowed, or cowardly; or what the mutual relations, if any, are between host and Cuckoo during the laying of the Cuckoo Queen and later.